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AMERICAN RAILWAY JOURNAL.

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ENGINEERING NEWS.

AMERICAN LOCOMOTIVE BUILDERS are cordially invited by the engineering committee of the proposed Edinburgh Exhibition of 1890 to send representative American passenger and freight engines. Six or seven of the leading firms of this country have been addressed. Competitive trials are to be arranged for, tending to show the relative power speed, and economy of the American and English types.

A COMPOUND LOCOMOTIVE for the Baltimore & Ohio Railroad has recently been turned out by the Baldwin Locomotive Works, of Philadelphia, Pa. It has four cylinders, a high and a low pressure on each side; the former is placed above the latter, and both piston rods are connected to the same cross-head. The cylinders are 12 and 20 ins. diameter, 24 ins. stroke. Driving wheels, 66 ins. diameter. The boiler is 60 ins. diameter, with a firebox 9 ft. long for burning soft coal. The engine is designed for fast passenger service. The plan of construction has been patented by the Baldwin Works.

THE LOCALITY FOR THE 1892 FAIR is already settled in favor of Chicago, if Chicago papers tell the truth. It depends finally, of course, on the action of Congress, and of 325 members of the House; 162, lacking only one of a majority, are claimed to be pledged to Chicago as a first choice, with 40 others favoring it as a second choice. The Senate has a large proportion of Eastern members and is not claimed to be in favor of Chicago, but it is claimed that on joint ballot Chicago can command a large majority.

CONCERNING THE EXPOSITION OF 1892, *Le Petit Journal* of Oct. 24 says that Chicago has by no means given up hopes of securing the site and has sent to Paris Mr. JAFFREY, who is to be the Director General, and Mr. O. CHANUTE, who is to be the Chief Engineer of the proposed exhibition. These gentlemen arrived in Paris on Oct. 23, and at once called upon MM. BERGER and ALPHAND for the purpose of collecting general information concerning the organization of the French Exposition. If our French contemporary is correct in its statement, this looks much more like "business" than the general run of Exposition committee work in New York.

THE NEW SAULT STE. MARIE LOCK, now under construction, will have the following dimensions:

Length of chamber	800	ft.
Width of chamber	100	"
Depth of chamber	43½	"
Depth on mitre sill	21	"
Lift of lock	18	"
Capacity of lock	3,440,000	cu. ft.

This lock will accommodate at one time four vessels, each 350 ft. long by 46 ft. beam. The Canadian lock now being built at the same place will be somewhat longer still.

THE MANCHESTER SHIP CANAL, in its lower part, extending from Eastham to Ince Lighthouse, about six miles, has sustained severe damage from the high tides and gales of the early part of October. The embankments made to keep out the waters of the Mersey, which would otherwise cover this part of the works at high tide, have been washed away in several places, and the cuttings inside flooded. All parts of the embankment that were completed and faced with sandstone blocks escaped injury.

THE TRINITY VALLEY, TEXAS, IMPROVEMENT CO. proposes to spend $1,500,000 in straightening the river near Dallas, and thus to carry off the flood water more rapidly, and then to reclaim 100,000 acres of land by the erection of substantial levees. By so doing they expect to raise the value of this land from practically nothing to at least $100 per acre.

PRESIDENT CHENEY, of the Nicaragua Canal Company, declares that ships will undoubtedly be able to pass through Central America from the Atlantic to the Pacific by the close of 1894. Work is being pushed vigorously, although, of course, as yet on a comparatively small scale, which economy requires in the preliminary stages of so great a work. The controversy between the Governments of Nicaragua and Costa Rica has been settled. The prospects for the verification of the prediction appear to be excellent.

OF THE TOTAL STEAM TONNAGE IN THE WORLD, says *Lloyd's Register*, 88.7 per cent. was built in Great Britain, and 82 2 per cent. of the steel steam tonnage was built in the same country. Of the 11,552,101 tons of sea-going steam tonnage, 63 3 per cent. belongs to the British Empire. Of the 10,260 steamers of over 100 tons gross register, England has 5,914, and the United States but 425. And finally of the foreign freight tonnage of the world, 71 per cent. is carried in British ships. And as showing that England proposes to maintain this maritime supremacy, the *Register* further states that on Sept. 31, last, there were under construction in Great Britain 903 vessels of an aggregate tonnage of 1,697 432 tons, as compared with 729 ships, and 1,342,922 total tons at the same period last year. In the light of this exhibit, the present status of American shipping is not satisfactory; and the question of improving it is a formidable but all-important one, that the coming Congress should not neglect.

THE TWO-AMERICAS COMMERCIAL ROUTE, proposed by COL. GUSTAV A. KARWIESE, includes a railway from Rio Janeiro through Brazil to Bogota, in Colombia, thence to Barranquilla on the Carribean Sea. From that point a steamship line is proposed to Galveston, Texas, and then rail to Kansas City.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a collision on the Pittsburg, Fort Wayne & Chicago Railroad, Oct. 30. An east-bound freight broke down at a point between Homewood and Beaver Falls, and when the limited reached Homewood orders were received to take the west-bound track so as to get around the wreck. The passenger train was a very heavy one, and as there is a considerable grade at the cross-over, the engineer ran some distance beyond the switch so as to gain a momentum to overcome the grade. Just as the freight was backing toward the switch a freight train, also east bound, crashed into the rear of the limited and telescoped the observation car into the rear Pullman on the train. One man was killed, and a number of freight cars were wrecked. The freight is said to have been following the passenger train too closely.—A serious derailment occurred on the Chicago, Santa Fé & California Railroad near Carrollton, Mo., Oct. 31, owing, it is reported, to spreading of the rails on a part of the track which was not in good condition. Three cars went down the bank, and 7 persons were injured.—A collision occurred on the New York Central road, on Nov. 3, near Stuyvesant; a misplaced switch turning a south-bound freight train into the north-bound track where another freight train was standing.

A "SPLIT SWITCH" DISASTER occurred on the Lake Shore & Michigan Southern Ry. near Wauwaka, Ind., on Oct. 30. According to press dispatches, the train was running at a high rate of speed. When a short distance east of the switch at Wauwaka, a side bar on the locomotive broke and the whirling rod struck the switch bar squarely, breaking it open, after the engine had passed in safety. The remainder of the train was diverted onto the switch and beyond over numerous obstructions. Accidents of this apparently improbable character are by no means rare. —Another derailment caused by a broken rail occurred Nov. 3 on the Santa Fé road near Brownwood, Tex. Two cars were derailed and smashed, and the wreck caught fire, but the flames were quickly extinguished. There were 4 persons fatally injured.

SEVERAL LANDSLIDES, caused by the recent storm, have occurred on the San Francisco & North Pacific Railroad, between Cloverdale and Ukiah, Cal. —Heavy snow storms have occurred in Colorado, Nebraska, and Wyoming; blocking railway traffic in some cases.—A dam near Oroville, Cal., has been carried away by floods.—The embankment of a bridge approach near Enfield, R. I., was washed out Nov. 3.

EARTHQUAKE SHOCKS were felt on Nov. 2 over a large area of Missouri and Illinois. In Cape Girardeau, Mo., and Belleville, Ill., chimneys were thrown down and windows broken, while in a large number of towns the shocks caused doors, windows, and crockery to rattle. The shocks are reported to have been quite severe.

BRIDGE AND TRESTLE ACCIDENTS are reported as follows: A trestle being built on the line of the extension of the Georgia Pacific Railroad from Irondale to Oxmore, Ala., gave way Oct. 31, and some of the men at work upon it were injured.—Floods have damaged the supports of a temporary railway bridge at Williamsport, Pa., and of the Northern Central Railroad bridge near Field Station.

A SERIOUS ACCIDENT IN THE NEW WATER-WORKS TUNNEL AT CLEVELAND, O., occurred recently. A quicksand bed, which had been passed, broke through into the tunnel, but the workmen escaped to the air lock. The brick walls are said to have been maliciously broken and detectives have been put to work on the case. A local paper gives the following as the language of Mr. J. F. WHITELAW, the engineer at the water-works: "When the water had been forced from the tunnel we found a hole which had evidently been punched through the brickwork of the side. It was about 2 ft. by 20 ins. in size. Brick chips were found about the hole, and there was no indication of any settlement of the masonry. In addition to this, new brick, with no mortar attached, were found in front of the hole. This looks very suspicious. A man who is in charge of the work said that he never saw better mortar than that which they were using, and if the bricks were forced out of properly completed work, the mortar would adhere to them. The entire affair is suspicious in the extreme." There was no other reason to think that the rupture in the wall had been caused intentionally, except that "when the quicksand was passed, and the solid clay reached, it was found to be 'salted,' which, of course, made it crumble. It was found, however, by the tool marks, that the clay was solid naturally."

THE TIEN TSIN RAILWAY EXTENSION, says the Shanghai *Mercury*, will be actively commenced in the coming winter, and "it is to be pushed for-

ward as rapidly as possible." A quantity of plant is said to be already ordered from Europe. The *Mercury* also expects that a large loan will shortly be placed on the market in connection with this scheme.

WHETHER THE PROPOSED OMAHA UNION DEPOT, described and illustrated in our issue of Aug. 17, 1889, will be built or not, depends on the result of a special election to be held in Omaha on Nov. 28, to determine whether the city shall appropriate $150,000 in aid of the enterprise.

AGRICULTURE IN THE UNITED STATES, says Secretary RUSK in his last report, employs 10,000,000 persons on the 5,000,000 farms of this country, or supports a population of 30,000,000, and the annual revenue derived from it is nearly 4,000 million dollars. The value of the live stock alone is estimated at 2,507 million dollars.

THE MOUNT AUBURN INCLINED RAILWAY in Cincinnati is to be entirely reconstructed by Mr GEORGE HORNUNG, consulting civil and mechanical engineer of that city. This is the road upon which the accident of Oct. 15 occurred.

A SERIES OF TESTS OF AMERICAN CEMENTS is to be undertaken by the engineering department of Iowa State University, and a note addressed to cement manufacturers regarding it will be found in our advertising columns. The tests are to be conducted according to the standard method approved by the American Society of Civil Engineers, and the results will be awaited with much interest.

IMMIGRATION is again increasing, being for September nearly as much as a year ago, or 38,544 against 39,865. For the nine months ending with September, however, the totals are 399,108, against 432,807, a year ago, a decrease of 22 per cent. Italian immigration, however, has largely fallen off. So far as immigration is a sign of the times, it indicates continued fair weather in financial matters.

THE W. R. GRACE-PERU CONTRACT seems to have been at last consummated after four years negotiation. According to the report, W. R. GRACE & Co. of New York and the English owners of $280,000,000 of Peruvian bonds, on the one hand, and the Republic of Peru, on the other, have entered into the following agreement: The owners of the $280,000,000 bonds relinquish their securities as a claim on Peru, in return for a contract, to last 66 years, whereby the management of all of the railways, large mining interests, all of the guano deposits not now owned by Chili, extensive concessions of land said to be in the neighborhood of 4,000,000 acres, and the payment of $400,000 annually by the custom house at Callao, are turned over to the representatives of the English bondholders. These representatives are to develop the mines and the guano deposits, to improve the lands turned over to them, and to develop and improve the railways. It will require something like $30,000,000 to put the railways in first-class shape.

THE ELASTIC TILE, invented by Sir E. J. HARTLAND, of Belfast, is made by taking a mixture of India rubber, or India rubber compound, sulphur and pigment, and heating in a mold, in the ordinary way of making vulcanized India rubber; or the mixture can be vulcanized in sheets, and the sheets cut into tiles. These can then be affixed to the floor or other surface, to be covered in various ways, but the inventor prefers a cement composed of two parts of gutta percha, one part of resin, and one part of Stockholm tar. Being soft and elastic, these tiles form a very firm and comfortable foothold, and they are particularly useful on board ships, and, being impervious to wet, are always clean.

THE ASPHALT MINES OF UTAH are owned by the North American Asphalt Co. They are situated near Thistle Station on the Denver & Rio Grande Western Railroad, and the asphalt occurs in a sandstone rock, which contains from 20 to 50 per cent. of pure asphalt. The mines cover 640 acres, with four distinct veins varying from 6 to 20 ft. in thickness. This rock is crushed and ground and sold for $10 per ton, f. o. b., at Thistle Station. Another vein near Provo is claimed to show 80 per cent. pure bitumen. The freight costs 67½ cts. per cwt. to Chicago, and 91¼ cts. to New York. It is said 1,500 tons per month can be shipped.

A New System of Fireproof Floor Construction.

The ordinary system of fireproof floor construction, consisting of rolled I beams between which brick arches are turned, is familiar to every one. Its chief disadvantages are the excessive weight, cost, and space required, for the arches are usually no more than 4 to 6 ft. span, and a great number of beams is therefore required. The Guastavino Fireproof Construction Company, of this city, is now introducing a new system of fireproof floor construction, which has many features of superiority to the ordinary system, and is especially valuable in that it reduces the cost of a fireproof floor by nearly one-third.

The general features of the construction are the use to form the arches of a hard, well-burnt clay tile, about 1 in. thick, 6 ins. wide, and 12 ins. long, laid flat, with the several courses breaking joints. A very light centering is used, and the first layer of tiles is laid with a quick-setting mortar, composed principally of plaster-of-Paris. The other layers are laid in a mortar composed chiefly of Portland cement. Its exact composition is a secret; but it adheres so closely to the tile, and is so firm and solid when it has fully hardened, that its strength is about equal to that of the tile itself, and the whole arch is practically a monolithic mass, showing no tendency to separate at the joints more than at any other point.

These tile arches are built in spans of 5 ft. upward, and either as plain cylindrical arches or as "dome" arches, as shown in the perspective view. The weight of the tiles is about 100 lbs. per cu. ft.; hence an arch built of three layers of tile, which may be used for spans as great as 12 ft., will weigh about 35 to 40 lbs. per sq. ft., or but little more than half the weight of the brick arches as ordinarily constructed. The principal saving, however, is in the reduced number of beams used, owing to the considerably greater span which may be made with the tile arch.

The company's specification for erection of tile arches is as follows:

The spring of the arch will generally be 10 per cent. of the span in the clear.

Number of courses 1 in. thick required as follows: (each course is 1 in. in thickness).

	No. of Courses.	*Safe load per sq. ft.*	*Breaking load per sq. ft.*
For 5-ft. span	2	987 lbs.	9,872 lbs.
Above 5-ft. span and not exceeding 12 ft.	3	615 "	6,156 "
Above 12-ft. span and not exceeding 16 ft.	4	614 "	6,148 "
Above 16-ft. span and not exceeding 20 ft.	5	614 "	6,140 "
Above 20-ft. span and not exceeding 24 ft.	6	613 "	6,132 "

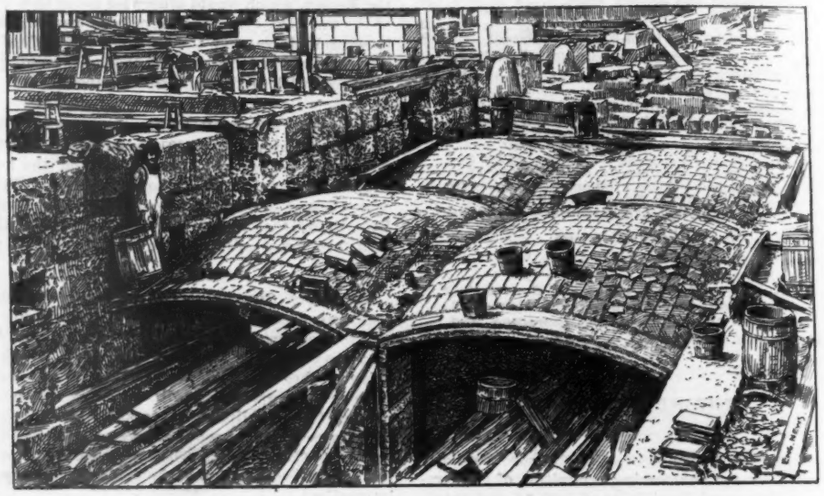
Dome arches as follows:

	No. of Courses.	*Safe load per sq. ft.*	*Breaking load per sq. ft.*
From 5 ft. to 12 ft. span	2	822 lbs.	8,224 lbs.
From 12 ft. to 16 ft. span	3	924 "	9,246 "
From 16 ft. to 20 ft. span	4	983 "	9,836 "
From 20 ft. to 24 ft. span	5	1,026 "	10,260 "

The arches to have proper skewbacks in the walls provided by the owner.

The arches will be built of hard, well-burnt clay tiles, the first course having the vertical joints of plaster-of-Paris, mixed according to our principle, and the second course having one tile laid in plaster-of-Paris and every alternate tile laid in Portland cement, all courses after second course being laid in a mixture of Portland cement. The tiles will be laid in the best, most substantial, and workmanlike manner by the employés of the Guastavino Fireproof Construction Co.

The main walls will be built and the main girders provided and set by the owner.



A New System of Fireproof Floor Construction.
Tile Arches in New Public Library Building, Boston, Mass.

The owner will provide heat in the building in cold weather.

If, instead of a uniformly distributed load, we have to provide for a very heavy concentrated load, or heavy moving loads or vibrations, we employ bridges of tile built 2 ft. apart on the top of the arch up to the level of the crown of the arch, in order to keep the curve of pressure intact.

The prices for the work vary, of course, with the span and number of courses and also with the location and size of the building under contract. From 30 to 70 cts. per sq. ft. is about the usual range of prices. As indicated above, the company's method of doing work is to take the contract for the entire fireproofing of a building; and they will estimate for this work when informed of the general arrangement of rooms, etc., in a proposed structure.

The system is by no means an experimental one, as a large number of buildings have already been erected with it and many others are in process of construction. Among notable buildings in and near New York City employing this method are the Atlantic Brewery on Staten Island, the Corbin Building, the Mt. Sinai Hospital, the Young Women's Christian Association Building in Sixteenth St. and the Plaza Hotel at Fifty-Ninth St. and Fifth Ave. The new Public Library Building at Boston is also being built by the system, and some of the domed arches under construction are shown in the accompanying engraving, made from a photograph.

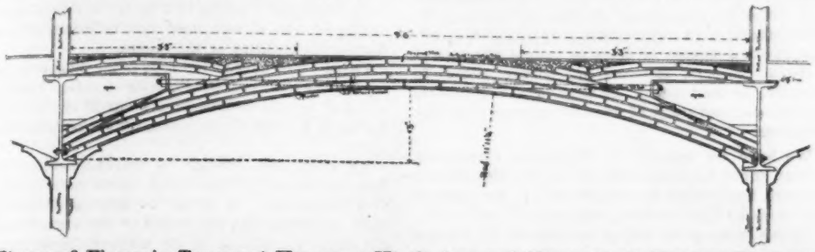
The accompanying engravings show the arches in the Arion Club building at Fifty-Ninth St. and Park Ave., and those in the new five-story fireproof apartment buildings erected at Ninth Avenue and Ninety-Ninth St., and Ninth Avenue and One Hundredth St.

In the Arion Club building the arches are 7 ft. span. In the Young Women's Christian Association Building there are some arches of 29 ft. span. The company is now erecting a building at Fifty-

Seventh St. and Eleventh Ave. in this city which will have an arch of 40 ft. span for the roof. The building will contain the company's general offices, draughting rooms, etc.

With these tile arches some very fine architectural effects are possible. Where it is desired to leave the soffit of the arch exposed, a special flanged tile can be used which shows no joints when laid. Where desired, also, enameled tiles can be used for the soffit, of such color as the architect may desire.

The great points of excellence claimed for this type of construction, however, are cheapness and great strength. In the construction of the Boston Public Library building, a heavy iron pillar fell from a derrick and went end first through one of these arches. The arch, however, was not shattered by the blow, but remained solid and unharmed except for the hole broken out where the pillar went through.



Fireproof Floors in Tenement Houses at Ninth Ave. and Ninety-ninth St. New York City.
(Cross-Section showing Rolled Beams and Guastavino Tile Arches.)

The following gives the results of a test of ultimate tensile strength made on a Fairbanks testing machine by N. O. OLSEN, 84 Thomas St., New York City, Oct. 21, 1889. The test pieces consisted of tiles cemented together in the same manner as in an ordinary arch, forming a rectangular block. Test piece No. 1 was 2 years old and test piece No. 2 was 2½ months old.

	Block No. 1	*Block No. 2*
Length	12.5 ins.	12.5 ins
Breadth	12.5 "	12.5 "
Thickness	3.25 "	3.00 "
Area of cross section	40.625 sq. ins.	37.500 sq. ins.
Breaking load of specimen	133,600 lbs.	51,680 lbs.
" " per sq. in.	3,290 lbs.	1,378 lbs.

This system of construction has been in use in Spain for a number of years and some notable buildings have been erected by it. One which should interest factory builders in this country is a 1,000 loom silk mill at Barcelona, 371 ft. x 330 ft. in size. The weaving room occupies, of course, the whole of one floor, and its arched ceiling is supported by 396 iron columns.

The offices of the Guastavino Construction Company in this city are at 35 Broadway and at West Fifty-Seventh St. and Eleventh Ave. The Boston offices are in the Pierce Building.

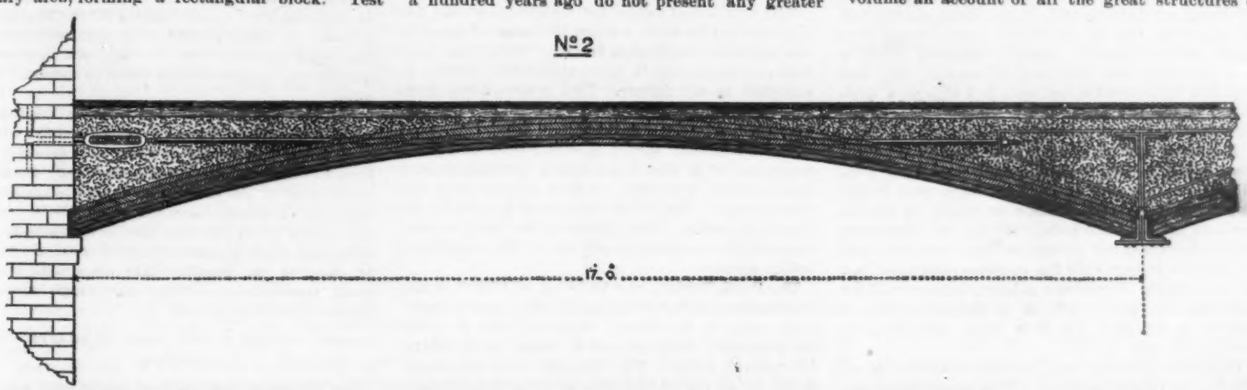
THE NEW *World* BUILDING in this city, which is now well advanced, will be 350 ft. high to the top of the flag-staff (within 20 ft. of the distance from the pavement to the top of the cross of St. Paul's Cathedral), with 35 ft. foundations underground. The building will be 18 stories high, including the foundation stories, and 6 elevators will be run. Two 300 H. P. engines will be required and 1,800 incandescent lamps will furnish light.

The Economic Conditions of Long-Span Bridges with Special Reference to the Proposed North River Bridge at New York City.*

That facility and rapidity of communication is a primary cause of civilization is recognized as an axiomatic truth It is a popular saying that the civilization of any country or nation may be judged from the number and condition of its roads.

The modern development of a country takes first the form of steamer lines, railroads, and telegraphs, all for rapid communication. It includes the greatest economic problems for human energy and endeavor,—the economy of matter, power, time, and space. As a special application, we all recognize the great convenience and economy of unbroken and rapid communication over wide and deep rivers and estuaries, irrespective of wind and ice, by means of long bridges, and, where necessary, by means of long span bridges.

The art of bridge building is ancient; the science of bridge building is modern. The bridges of only a hundred years ago do not present any greater merits, if so great, as the bridges built one or two thousand years ago.



General Section of the Floor Arches in the Arion Club Building, cor. Fifty-ninth St. and Park Ave., New York City.
(Safe Load on Arch 723 lbs. per sq. ft.

The bridge over the Euphrates at Babylon, built in the reign of SEMIRAMIS (about 830 B. C.) and described by HERODOTUS was as great an undertaking as any that we have record of even to most recent times. The diversion of a deep navigable stream, 2,000 ft. wide, for the purpose of building the pier foundations for that bridge, would even for our time be called a great work, were it necessary to undertake it.

China has stone and suspension bridges many hundred years old, of unexampled magnitude in any other country at much later times.

The limit in bridge construction which human energy and enterprise could achieve on a merely empirical basis, has been reached long ago. The longest span of a scientifically proportioned stone arch bridge, "the Cabin John Valley Aqueduct Bridge," (220 ft. span, built in 1870 by Gen. MEIGS, U. S. Army) had been anticipated nearly 500 years ago by a stone arch bridge of 251 span over the Adda at Trezzo (built in 1380, and destroyed 1430 by the Venetians). The latter had been built on empirical principles only; at that time there did not exist even the beginning of mathematical mechanics.

The greatest and best of wooden bridges, even to 50 years ago, were no greater achievements than was the often described great wooden arch bridge over the Danube below the rapids of the "Iron Gate," built in the reign of the Roman Emperor TRAJAN, 104 A. D. It was over 4,000 ft. long and had 170 ft. spans. Remains of the piers, founded in water 18 ft. deep, can yet be seen.

In military bridges, where fertility of resource and determination in the face of great danger are as important as constructive skill, the ancients and the mediævals have not been surpassed. The pontoon bridge over the Hellespont for the army of XERXES; the pile bridge of CÆSAR, built in ten days over the turbulent Rhine, and in the face of the enemy; the pile and flatboat bridge, built by the Duke of Parma in 1584 over the tidal river Schelde (2,600 ft. wide and 60 to 80 ft. deep) during the siege of Antwerp,—either of these achievements has not been excelled in modern history, considering the resources of the respective times. Human energy, enterprise, and intelligence have, it seems, been the same, as far as history can inform us of the great and powerful nations that have lived and gone; but human knowledge has increased, and with it the field of its application.

Stone and wood have been superseded by iron and steel as materials for the superstructure of bridges. With the development of the metallurgical arts, with the cheapening of the once costly metals, came their use for bridges in a manner and in a magnitude that would have been considered fabulous only two generations ago.

The art of iron bridge building is less than 100 years old; the science of iron bridge construction is less than 40 years old,—very small periods indeed as compared with what it will be in the future. And what has been achieved? While a compendium of bridges 10 years ago would hold within a slender volume an account of all the great structures of recent times, these have multiplied to an extent that would fill many such volumes now.

And the time of iron and steel bridge building has only begun. Imagine what it will be when the second centennial of the inauguration of WASHINGTON as first President of the United States will be celebrated.

The North River at New York will be spanned by more than one bridge. The East River—bridged at present only by the magnificent suspension bridge at Brooklyn—will have as many great bridges over it as Chicago has now over its narrow river.

In anticipation of the first bridge intended to be built over the North River at New York, it will be interesting to consider the leading economical principles for long-span bridges in general.

I.—SELECTION OF THE BRIDGE TYPE.

The science of bridge building, having and progressing from a mathematical foundation, enables the engineer to work out results and to predict effects with increasing precision. We can closely calculate the stress in each member, and proportion its strength for any condition of loads. We can tell in advance how much a bridge will deflect under certain loads, or under temperature effects. We can determine its rigidity, even the extent of oscillation under defined speeds of railroad trains. The princi-

* Address before the American Association for the Advancement of Science (Section D) at the Toronto meeting by GUSTAV LINDENTHAL Civil Engineer.

pal types and combination of types, their merits and demerits, are now better understood.

Several kinds of trusses, which only a few years ago were frequently built as having special vague advantages, have become obsolete and have gone out of use. Experience and a more rational and developed analysis of strains and of the dynamical effects, point to the gradual elimination of other types yet used for construction.

The first long-span bridges, by which may be understood bridges of steel and iron of about 400 ft. or more in length, for railroad purposes, have been built in England. They were of the type called "tubular girders," of which the well-known Britannia Bridge (built 1850) in England, and later the Victoria Bridge at Montreal, Canada, with shorter spans, are the most prominent examples. In their design, theory and empiricism were yet intermingled in determining the dimensions. Though very wasteful in the use of iron, in their conception and execution these bridges will always remain monuments of great engineering skill. They must be judged by the standard of their time. The same bridges, built on modern designs and of greater strength, would require less than one-third of the metal, and could be built in less than one-fourth the time for less than one-fourth the cost. Greater bridges are now built as an every-day occurrence. Their cost has been decreasing yearly, though it may not perhaps continue to decrease materially for some time to come.

For spans exceeding 500 ft. in length, ordinary truss-bridges lose their economical value and other bridge systems offer then greater advantages.

All single-span truss bridges, whatever their form, whether parallel chords or not, whether full or latticed web, or whether the open, large panel web of special American design, belong to the class of beams.

Like any ordinary wooden beam, if lengthened out to cover several spans as a continuous beam (instead of being cut into several single beams, one for each span), iron trusses, when so made continuous over several spans, show increased rigidity and strength and economy of metal. The calculation is somewhat tedious, but this is a matter only for the engineer who builds them, and is no objection to their use in proper places.

The next type or system, now largely used for long spans, is the so-called cantilever bridge. Like all others, it is very old, and has been used in the remotest times, built of stone or wood. It simply consists of two brackets, corbels, or projecting beams, anchored fast at one end and reaching out beyond the supports till the opposite ends meet and are connected. Sometimes a beam is supported on and between these ends, or a three-hinged arch may be substituted for this beam according to local conditions.

The modern novelty consists in the construction of this system in steel and iron. Its application on the largest scale is in the Forth Bridge now nearing completion in Scotland, where the two channels of an estuary, each 1,700 ft. in width, have been bridged in this manner for a double-track railroad. Numerous examples on a smaller scale exist and are constantly added to in other parts of the world, particularly in East India and North America.

The erect arch, like the former types, is also of ancient origin, although for the simple constructive needs of the oldest historical nations, it was not as frequently used as the beam and the corbel or cantilever. The Romans were the first to apply the arch principle to timber bridges, after having long before used it for stone arches. Cast iron was the next material used for arch bridges, the oldest of which was built only about 110 years ago, namely, the bridge over the Severn at Colebrookdale.

Since then, arch bridges in cast iron, wrought iron, and steel have been built in all parts of the world; some of them beautiful and very substantial structures, promising to last centuries. But so far no greater span than 550 ft. (in the Garabit Bridge in France) has been constructed. The arch-type lends itself very well and economically to much longer spans than either the continuous girder or the cantilever system, provided the local conditions are favorable for the necessary substantial abutments, against which the arches rest.

But the bridge type pre-eminently adapted for the very longest span attainable is that of the suspension bridge. It is as old as mankind itself, perhaps even older. Zoölogists tell us of the methods employed by apes in crossing streams. Failing to find a fallen tree to act as a beam or truss bridge, or failing to find meeting tree branches forming a sort of cantilever bridge, apes, we are told, form a chain by hanging together hands and tails, and suspended thus over a stream from tree to tree, the rest of the tribe climb along this living bridge from shore to shore. The strength of the chain with its weakest link, was, in this case, the weakest monkey; and there can be little doubt that occasional failures of such living bridges must have engrafted that bit of wisdom early on our anthropological ancestors. Modern bridge engineering, based on mathematical deductions, could not improve it. When MONTGOMERY, in his famous description of the Brooklyn Suspension Bridge, referred to its ethnical origin in the suspension bridge of the savage, the two stumps of trees as towers, the rope of twisted creepers, fastened at either shore to boulders as anchorages, he described a comparatively advanced stage of remote suspension bridge building.

We have an account of a Chinese suspension bridge, equal in magnitude of span to ROEBLING's Niagara Suspension Bridge (800 ft.) It was built of chains in the first century; remains of it still exist.

Since a suspension bridge requires of all bridges the least amount of metal, it is quite natural that the first metal bridges should be of the suspension type on the same economic grounds which, to this day, determine its choice. The facility with which they could be erected induced bridge builders to use them for longer and longer spans. The first longest span bridges were of the suspension type; modern bridge engineering has not discovered a more economical type for the very longest spans. It is, however, a noteworthy fact that scientifically the suspension bridge systems were the slowest to develop to correct theoretical application.

The economical values for long spans of the five principal bridge types are not the same. Lowest in the scale are single-span trusses. They have been built, so far, to 540 ft. span, which will hardly be exceeded in the future. This is considered their economical limit, beyond which the following types give cheaper and better bridges.

The continuous girder is economical only for a succession of at least three spans, of which the end spans should be at least one-fifth shorter than the middle span. This latter may reach to 2,000 ft. for a railroad bridge. Two thousand feet may be considered the economical limit also of the cantilever bridge system.

The Forth Bridge, now building, of 1,700 ft. span, will likely remain for a long time the longest cantilever bridge in the world. Spans of 4,000 ft. could be bridged, if necessary, with a steel arch bridge for railroad trains. The roadway need not necessarily be on top of the arch as in a stone bridge, but may be suspended from the arch, as in the Douro arch bridge in Portugal. Arch bridges can also be erected without false work if necessary. Two of the most famous arch bridges of modern design have been so erected, namely, the St. Louis arch bridge, built by the late Captain EADS, and the Garabit viaduct, built by GUSTAVE EIFFEL. Both have 500 ft. span.

But where the local conditions are favorable to a large arch bridge, and particularly to the erection without false works, the conditions will be found, as a rule, favorable to a suspension bridge, capable of the greatest economy of all known bridge types, and the one type capable of application to the longest possible spans. Single spans of over 6,000 ft. could be bridged for railroad trains, if necessary, with cables of steel wire, having a breaking strength of 170,000 lbs. per sq. in., which is the strength of wire in the Brooklyn Suspension Bridge. But steel wire suitable for bridge building can be obtained now having a breaking strength of 240,000 lbs. per sq. in., if price for the same were no objection.

The choice of the suspension type for the proposed railway bridge over the North River at New York City is justified:

First.—By the local conditions which require a single span over the most valuable and increasingly crowded water highway in the United States. The unanimous popular and local sentiment is against any bridge which would require one or more piers between the shores. Just as the East River, between New York and Brooklyn, has not been allowed to be bridged, and will never be bridged otherwise than without piers in the river, so the North River, between New York and Jersey City, more important yet as a commercial highway, is not to be bridged except with a single span; or it may be tunnelled.

A river span of 2,850 ft. will span the entire river; and the two shore spans will be 1,500 ft. each. The bridge will reach over valuable property on either shore, which otherwise would be destroyed and become useless for business purposes. It will be 150 ft. above the water.

Second.—The North River Suspension Bridge can be erected without false works, from anchorage to anchorage, for a length of 6,000 ft. Navigation and traffic on the streets need not be interfered with during the building of the bridge.

Third.—The suspension type is the most economical for the locality. Single-span trusses, continuous and cantilever trusses, are out of the question for such a long single span, for the reasons given above.

An erect arch bridge is impracticable. The foundations for the abutments would have to be in very deep water. It would be impossible to build them so secure that the thrust of the arches would not cause a yielding of the masonry mass on the foundation. The weight of masonry under water is only about one-half of that out of the water, on account of displacement. The resisting mass would have to be enormously large. But in very deep water it could not be perfectly bonded to the foundation because of the impossibility of reaching very great depths otherwise than with dredging tools. The pneumatic method of foundation is not applicable to greater depth than about 120 ft. Beyond that the mortality among the workingmen would increase to a criminal and murderous extent. Some engineers would not risk the pneumatic method beyond 100 ft. in material such as the bottom of the North River consists of, namely, mud with sand with boulders and sand pockets down to deep rock in uncertain quantities,—a combination liable to sudden "blow-outs."

Fourth.—The towers, which alone require the deep foundations, have to resist merely vertical pressure. The foundations are not exposed to any thrust or other lateral force. The pull from the large cables of the suspension bridge is resisted by the large anchorage masses, placed 1,500 ft. back of the towers, where the rock rises to the surface. The cables can there be rooted into the rock. No sliding or shearing can possibly take place with the proposed construction of the anchorage masonry, bonded into the solid rock.

II.—THE NATURE OF THE LOADS OR TRAFFIC OVER A BRIDGE.

The nature of the loads or traffic over a bridge was always held to have a decisive influence on the choice of the type for long-span bridges.

Thus, for wagon and street traffic, suspension bridges were considered safe and proper; but when the problem arose of long spans for railroad traffic, the most eminent engineers at first disagreed widely in their judgment. Still, it is a noteworthy fact that already in the earliest designs for railroad bridges the suspension type was thought of and seriously considered. Thus, the first designs for the long-span bridge over the Menai Straits were on the suspension principle, stiffened by plate girders. From tests with models it was then concluded that the chains could be dispensed with for the proposed 460 ft. spans if the strength of the girders were increased, and out of the original suspension bridge was evolved the tubular bridge, built as a continuous beam of four spans.

BRUNEL's bridge over the Saltash near Plymouth in England is derived from a similar idea of chain stiffening, but in this case, the tube was ingeniously placed above the chain as an arch, the thrust of which equals the pull of the chain, and the bracing placed between them furnishes the required stiffening.

ROEBLING's success with long-span bridges for wagon traffic encouraged him to propose a railroad bridge on the suspension principle over the Niagara River. He reasoned that, as the jolting of heavy teams on the suspension bridges he had built before produced no noticeable deformation, and that

the oscillations became less the longer the span, the smoothly rolling loads of railroad trains would still less affect them. That his conclusions were right, can be witnessed daily on his railroad bridge below the Niagara Falls (built in 1854). This, however, was not the only suspension bridge built for railroad traffic. There was a chain bridge for a double-track railroad in Vienna, built a few years later, which did excellent service for fifteen years. The rigidity provided for it, however, as in most suspension bridges, had not been sufficient, and, although safe otherwise, it was replaced a few years ago with a modern arch bridge.

Theoretically a suspension bridge is nothing else than an inverted arch bridge. The chains or cables take the place of the compression members of the arch. It follows that if the chains or cables were stiffened in the same manner, and of the same strength against deformation, as in an erect arch bridge, both systems should be equally stiff and rigid. As a matter of fact, the suspension bridge requires less stiffening, and with less stiffening is more rigid. Erect arches require lateral bracing to keep them in an upright position; without it they would fall of their own weight. Suspended arches require no such lateral bracing; they keep their form without it; they are in stable equilibrium as compared with erect arches, which are in unstable equilibrium. The weight of that lateral bracing in an erect arch is a large percentage (from 10 to 25 per cent.) of the total weight, which is unnecessary, and can be saved for suspended arches. This is an important economic feature in a long-span bridge.

A suspended bridge can be built of any degree of rigidity or without any. It will be safe, in any case, though it may sway and oscillate. For comfort and for fast speed, it is undesirable to have a swaying bridge. It requires stiffening. The different systems of stiffening are not alike in economical value or in merit.

The most frequent system is that of stiffening trusses. In very long spans and for railroad trains they require to be very substantial and become enormously heavy, though by no means as heavy as they would be in combination with a direct arch. They carry no part of the dead or live load; their own load must be carried by the cables. Their sole and only function is to preserve the form of the cables under passing loads. The heavier the cables, the smaller and the less frequent is the maximum work of the stiffening trusses, whose weight, however is not decreasing with the increasing length of span, but is increasing merely at a smaller ratio.

Split the cables and insert between them the web-bracing of the stiffening trusses, and the weight of the heavy truss chords is saved. The cables themselves will now act as the chords. They will form a curved stiffening frame, or suspended stiffened arch ribs.

The economy of the system is apparent, and it may be said that it is the most economical for very long spans that can ever be proposed, provided anchorages can be obtained without such great cost as to overbalance the economy in the suspended arches.

The suspended arch is no more subject to deformation from trains than the erect arch, as already remarked. But the knowledge that a suspension bridge is safe, whether stiffened or not, has caused many suspension bridges to be cheaply built, with insufficient stiffening; and as a consequence the notion has become popular that a suspension bridge is not rigid enough for railroad trains. This is a mistake which modern bridge engineers will not make. Empiricism is at an end as far as the rigidity and strength of suspension bridges are concerned. A truss bridge, of any description, a cantilever bridge, or an erect arch bridge, if as badly designed or insufficiently stiffened as most of the existing suspension bridges are, would not stand a single load, and most of them would fall of their own weight the moment they were released from the falsework. But a suspension bridge cannot fall as long as the cables and fastenings hold. What lighter bridge, for the same load, can there be of any one other kind than the one of a single wire rope on which BLONDIN walked across the abyss of the Niagara River?

The North River Bridge is designed on the principle just explained. The suspended arch ribs consist of steel wire cables with the bracing between them; the cables are 50 ft. apart. These arch-rib are so designed that they will preserve their form without change noticeable to the naked eye even in the case of six processions of locomotives advancing on it on all six tracks.

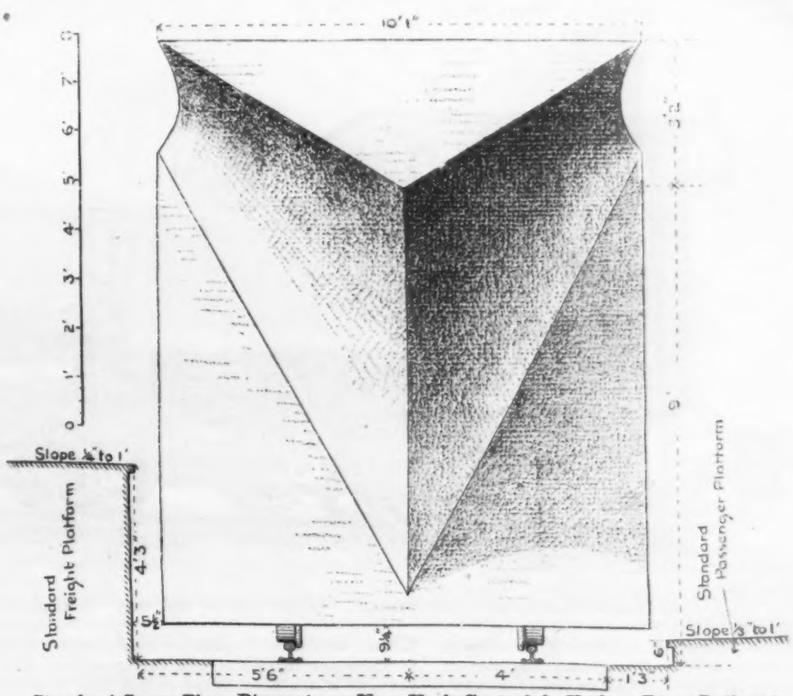
There are only two such arch ribs, though there are six tracks. The reason for this arrangement is as follows: In a single-track bridge, the two trusses supporting it are strained to their full capacity, more or less, from each train passing over it; in a double-track bridge, only when two trains meet; in a three-track bridge with two trusses, only when three trains meet; and so on to a six-track bridge, supported by two trusses or arch ribs, the maximum load occurs only when six trains happen to meet on it. The probability of frequency of trains meeting on the bridge is in a greatly decreasing ratio from a double track to a six-track bridge.

A long-span bridge can neither be so heavily nor so frequently loaded as one of short span. An ordinary street car, 16 ft. long, has about 120 sq. ft. on which at times 80 persons are squeezed together in a manner not possible on a street or on a bridge. Still the load will hardly exceed 100 lbs. per sq. ft. of street car. On a street bridge of 100 ft. span, it is conceivable that a crowd of people may congregate which would exert perhaps a pressure of 70 lbs. on the square foot average, though for the calculation a load of 100 lbs. per sq. ft. is usually assumed, as including the effect of impact, accumulation of snow and ice, etc. But on a bridge of 1,600 ft. span for instance, such an average load per square foot for the entire bridge from a crowd would be a physical impossibility under ordinary conditions. Thus if the Brooklyn Suspension Bridge, (having such a span of 1,600 ft.) should be loaded at the same rate as assumed for a 100 ft. span, it would take a mass of humanity of nearly 170,000 people, crowded together and suspended on the structure between the anchorages. The bridge would not yet give way, but long before only one-fifth of this number could get on the bridge, locomotion would be out of the question, and deaths by crushing in the crowd would be almost unavoidable.

Great, dense crowds rarely cover large areas; they cannot with safety to themselves do so, and therefore smaller assumptions of loads are justifiable for long-spans when they would not be for smaller spans.

What is true of a street bridge is in a measure true of a railroad bridge. The length of train and its load will depend on the grades up to the bridge. That load which the two heaviest engines can haul up the grades to the bridge will be the limit of live load for a long-span bridge provided that the train's length is shorter than the span. It is not conceivable in ordinary practice that such trains would follow each other closely on all six tracks at the same time. But the strength of the North River Bridge is to be such that ten double-headed freight trains, running on ten parallel tracks, five in, five out, could meet on the middle span of 2,850 ft. regularly every day right along without doing the bridge the least harm. It is easy to believe that such a meeting may not occur in a generation.

This great strength is obtained with comparatively less material than in shorter bridges. The live load forms only a fraction of the dead load. The difference in the strains of the loaded and unloaded structure become smaller as the span grows larger. Experience and exhaustive tests furnish us with the knowledge that this difference of the minimum and maximum strains has a close relation to the durability of the structure, and that the durability increases as this difference decreases.



Standard Snow Plow Dimensions, New York Central & Hudson River Railroad.

In other words, the durability of long-span bridge is greater than that of smaller span bridges, not only by reason of the greatly lessened frequency of the maximum loads, but also by reason of the more favorable relation of the strains from dead and live load.

Examples of this truth we find everywhere; to name only a few, there are the long-span suspension bridges at Wheeling and Cincinnati; with an ever increasing traffic, they are as good as ever. They show no signs of deterioration or weakening, while shorter span bridges of greater rigidity, in their immediate neighborhood, built after them, have had to be replaced; they were worn out and unsafe. There is no reason why the existing long-span bridges should not last many centuries, if carefully maintained.

(TO BE CONTINUED.)

Standard Snow Plow Dimensions.

In answer to a correspondent whose communication appears in our "Notes and Queries" column, and whose inquiries relate to a matter which is of general interest, we give herewith a cut showing the standard snow plow section and clearances of the New York Central & Hudson River Railroad, which we understand to be substantially in accordance with standard practice on all well-managed American roads. It will be observed that the clearance above the top of the rail is not fixed, but only above the base of the rail, 9¾ ins. With 4½ to 4⅝-in. rails, this leaves a scant 5 ins. of clearance, which certainly ought to be sufficient. The same clearance is retained at the side of the plow.

If any of our readers know of cases where the dimensions of this section are seriously varied from, they will oblige us and our correspondent by giving us further particulars as to the points of difference.

Two Rack-Rail Locomotives.

We find in almost simultaneous issues of *Engineering* and the *Railway Engineer* the accompanying engravings and details of two rack-rail locomotives of two different types, one of the Abt system, and one of the Riggenbach. The two engines differ materially in size, as will be seen from the engravings, which are to an approximately uniform scale, but they differ even more materially in design than they do in size.

The first and smallest locomotive is one of the Abt type, built for the Brünig Railway, which is being shown at the Paris Exhibition by the Swiss Locomotive & Engine Works of Winterthur, Mr. J. WEBER manager.

The engine is fitted with three different brakes; first, a brake on the Rigi system, which is used when the engine is descending gradients; second, a friction brake acting on the intermediate shaft; and third, a friction brake acting on a toothed wheel mounted loose on the leading axle, this wheel engaging with the rack. This latter brake is only intended for use in the event of a failure of the rack gear proper.

Besides these three brakes on the engine, the train is fitted with Klosé's automatic steam brake, which is under the control of the engine driver. The principle of the Klosé brake—which may be actuated either by steam or by compressed air—is as follows: The brake blocks are acted upon by powerful springs which tend to force them against a brake drum-keyed on the axle, the blocks being, however, ordinarily kept out of contact with the drum by steam or compressed air acting through a cylinder and piston and system of levers. On the steam or air being released from the pipes, the spring brings the brake into action throughout the train. In the case of the Brünig vehicles, the pipes which convey the steam through the train also serve for heating the vehicles. The steam connections between the carriages are made by metallic pipes arranged so as to permit free movement. The engines and carriages are coupled by a central combined coupling and buffer, there being also provided a steel wire rope which serves as a safety coupling.

Cylinders	13 × 18.9 ins.
Carrying wheels, diameter	2 ft. 7.34 ins.
Wheel base	7 " 10.34 "
Diameter of pitch circle of rack gear	2 " 7.34 "
Total heating surface	588 8 sq. ft.
Grate area	10.5 " "
Contents of tanks	617 galls.
" " fuel bunkers	8 cwt.
Total weight of engine empty, about	38,000 lbs.
Total weight of engine in working order about	49,300 lbs.

The engine described belongs to a type which was introduced during the season of 1888, and *Engineering* states that experience with it has shown that it is well fitted to fulfil the requirements of the service. On inclines of 12 per cent., or 1 in 8½, this engine will haul loads of 40 tons at a speed of over six miles per hour.

The second and larger locomotive is one which we find described in the London *Railway Engineer*, it being a double-geared rack-rail locomotive built by the Baldwin Locomotive Works, of Philadelphia, in March, 1889, for the Estrada de Ferro Principe do Gran Para, of Brazil. The Baldwin Locomotive Works had previously built two single-geared rack-rail locomotives of this system for the same railway, which were designed to haul 22 tons (of 2,240 lbs). of cars and load up a grade of 15 per cent. or 792 ft. per mile at a speed of 9 kilo. (5½ miles) per hour, or 18 tons at 11 kilos. (7 miles) per hour up the same grade.

The engine here illustrated is larger, and is designed to haul double these loads with the same pressure per tooth on the rack. Its general dimensions are as follows:

Gauge, one metre.

Fuel, briquettes of coal.

Boiler, 50 in. diameter; steel plates ⅜ in. thick; working steam pressure, 160 lbs per sq. in.

Tubes, charcoal iron, 149 2-in. diam., 11 ft. 2 ins. long.

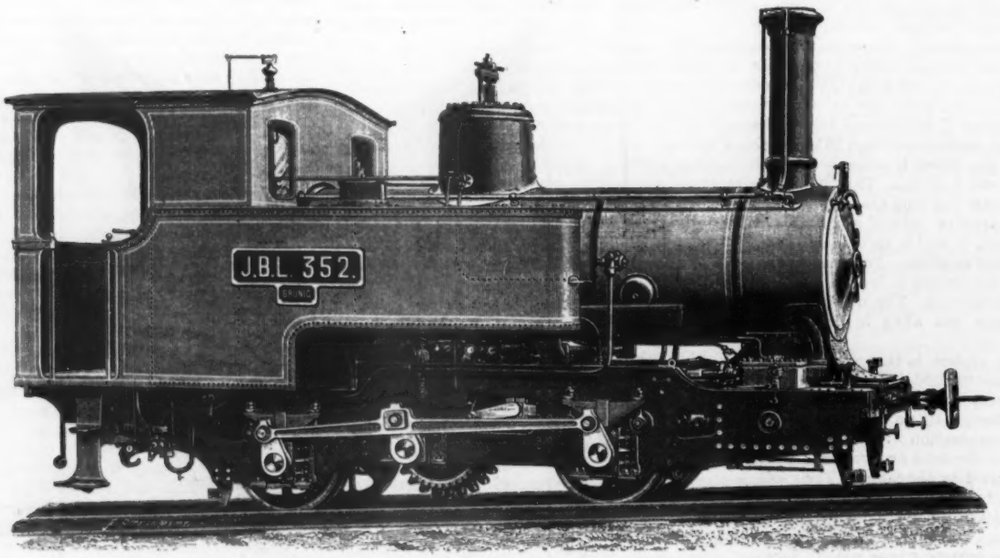
Firebox, steel, 66 ins. long, 49 ins. deep.

Wheel base, 15 ft. 8 ins.; driving wheel-base, 3 ft. 11 ins.; rigid wheel-base, 3 ft. 8 ins.

Cylinders, 17½ x 20 ins.

Diameter of geared-wheels, 41.35 ins. measured on the pitch line.

The engine is designed to pass curves of 150 metres radius.



Rack-Rail Locomotive, Abt System, for the Brunig Railway. Swiss Locomotive & Engine Works.

The Brünig Railway is a mountain line of metre gauge, about 10 miles in length, the chief part of this distance being laid with a central rack, while there are two short lengths which are worked by simple adhesion. On the rack portions the maximum gradient is 12 per cent., or 1 in 8½. The locomotive illustrated has been designed to meet the special conditions of working which this railway involves, it being capable of hauling the train either by simple adhesion or by the use of the central rack; while, moreover, as the lengths of line on which simple adhesion is alone used are short, it was not considered desirable to provide two sets of cylinders and gear, and in consequence the carrying wheels and the rack gear are coupled together, and are all worked by one pair of cylinders. These latter are inside the frames, and are in one casting with the valve chests on the top as shown in the engraving. The piston drives a crank shaft, the bearings of which are carried by internal frames, which connect them to the cylinders, this shaft being geared to the central axle on which the wheel engaging with the rack is mounted. At its outer ends this axle carries cranks by which it is coupled to the axles of the carrying wheels by coupling-rods of the form shown. To allow for the play of the springs belonging to the carrying axles, these couplings are made so that the blocks into which the central crank-pins enter are free to slide for a short distance vertically.

The boiler is of the ordinary locomotive type, the shell being of mild steel and the firebox of copper, while the tubes are of steel with copper ends next the firebox. The boiler is so mounted on the frames that it stands horizontal when the engine is on a gradient of 6 per cent. The water gauges are placed at the middle of the length of the boiler near the dome, so that their indications may not be interfered with by the gradients. The chief dimensions of the engine are as follows:

The back crank axle and the back carrying-wheels are fitted with hand screw-brake. The front crank axle and the front carrying-wheels are fitted with the Eames Vacuum Brake. The engine is also fitted with the Le Chatelier or water brake, acting by back pressure on piston. Tank, 900 galls. capacity. Screw reversing gear.

Weight in working order, including tank full of water, about 80,000 lbs. The line has maximum grades of 15 per cent. for 3.6 miles, and secondary grades of 8 per cent.

The engraving shows the method adopted for equalizing the power applied to the two main gear wheels. The power is transmitted from the pistons to a centrally located main shaft, and by means of compensating parallel rods the motion is conveyed to crank disc on separate shafts and thence to the main gear wheels.

The locomotive has arrived at Rio de Janeiro, but at last advices had not been placed in service. We believe ourselves that the Abt is a far better system than the Riggenbach, but either is sufficiently unusual. If only 3.6 miles of the extreme grade was needed, it was probably bad location to use it at all.

A PAN-AMERICAN CANAL, connecting the Atlantic and Pacific Oceans, is being mildly talked about as one result of the presence among us of the representatives of South America. Each nation and State interested is to contribute to the expense prorata, and it is supposed that in such distribution the United States would have the controlling interest. The advantages of this scheme are not set forth, other than to suggest that, in case of such united action, American shipping may be developed by imposing discriminating dues against European shipping using the canal.

Engineering Society Papers as Advertisements.*

BY OBERLIN SMITH, M. AM. SOC. C. E., M. AM. SOC. M. E.

Any document which is read aloud at a public or semi-public meeting and which is printed and distributed to a number of persons is, to some extenor other, an advertisement making known the author as well as the subject-matter treated of therein. In this sense all the papers read before and published in the transactions of, our various engineering and other scientific societies undoubtedly advertise something or somebody to a certain degree.

The object of the present essay is briefly to analyze this matter, and point out to what extent the advertising principle referred to may be carried consistently with the legitimate purposes of engineering papers in such organizations as our various national societies in America.

One perfectly harmless and legitimate extreme of a series of cases is where a purely scientific paper tells of a discovery of abstract principles or natural phenomena, or explains experiments and makes record of data concerning them. At the other extreme of the series, we have papers consisting simply of mechanical descriptions of new machines or devices which are fully protected, or about to be protected, by patents; and which are not of any particular use to engineers or the public from a scientific point of view—or even a practical one—except to relieve their purses after they have been sufficiently induced by the promoters to buy them and try them.

Between these two extremes are papers of all grades of usefulness and scientific interest, and all degrees of "advertisementableness," so to speak. The question which it is intended to bring before the various societies for consideration, and one which in the opinion of the writer it is very desirable that they should discuss, is where and by whom to draw the line. The second part of the question is, in the writer's opinion, easily settled. The matter should be decided by the publication committee of the society in question. Such committees are appointed especially for this very purpose, viz., to decide upon the usefulness and availability of all papers submitted to them. In addition to the ordinary considerations as to the literary and scientific merit of a paper, its present usefulness to the society and to the public, etc., such questions as the following should be asked: Is the device, process, or design described therein protected by patents or copyrights, or is it likely to be in the near future? If so, is it so new and wonderful that a knowledge of it will be of great interest to the society and to the public, in spite of its being a monopoly which it may cost them somewhat dearly to enjoy? If not of such exceptional and paramount, but only of moderate, interest, is there any guarantee that it will be given to the public at such a very low price that it is decidedly for their interest, rather than for that of the inventors or promoters only, that they should have all possible information concerning it?

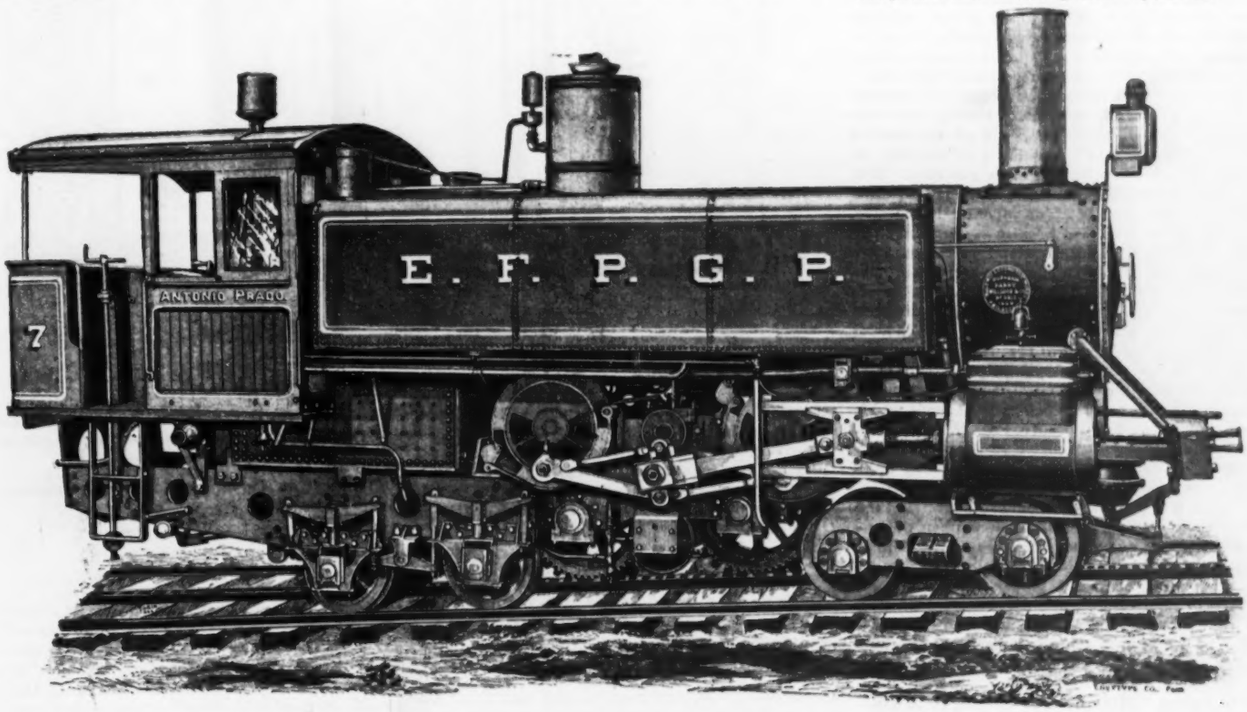
These questions may be somewhat embarrassing and delicate ones for a committee to decide upon, especially where their fellow-members are concerned, but their decision is certainly one of the responsibilities and duties which they have taken upon themselves, and each case should be decided rigidly upon their opinion of its merits. A practical suggestion here offered is that it should be the rule of the publication committee in the societies in question to ask the author of any paper which seems to describe a patentable device of no unique and startling novelty, whether he has patented it, or has any intention of doing so, or, on the other hand, whether it is given freely to the public in the interests of science. A suggestion to authors of future engineering papers is also here offered, viz., that they distinctly answer all the above questions in advance, when sending in a paper. The committee can then, of course, use their own judgment as to whether the offering is on the whole acceptable. A better plan, perhaps, would be a brief statement in the paper itself, as to whether or not its subject was free to the public. A case where no very definite line can be drawn is where mechanical devices described in papers are merely improvements on other devices which have already been patented, in which case the mere casual allusion to the latter does to some extent advertise them, albeit perhaps in no objectionable way.

If, to aid us in deciding the rather delicate questions here brought up, we look for analogies and precedents in other professions than engineering, we find that among the clergy and among lawyers there is, in their published writings or in their speeches before conventions or societies, absolutely no advertising except of the perfectly legitimate kind which advertises only the man himself, either favorably or otherwise, according to whether his character and ability have a plus or minus sign. Among physicians where, unlike the two classes before mentioned, there are many opportunities for monopolies, either by keeping instruments, processes, and medicines secret, or by patenting them, there is a very rigid professional etiquette against such monopoly; and it is only among so-called quacks that anything of the kind is allowed. As a general thing, and very fortunately too for suffering humanity, any discovery or invention by a physician is given freely to the world, and the members of the profession take a pride in thus making the results of their skill and research factors in the civilization and happiness of the race.

If we look for precedents among the proceedings of purely scientific societies, those for instance dealing with the various "ologies," and with astronomy, geography, botany, etc., we find much the same spirit—it very rarely happening that discoverers get any direct profit for their labor and research except as it adds to their general reputation.

If we look at the practices of the various great engineering societies in this country, we shall find that in the realms of civil engineering (and its twin sister, architecture) there is probably less of the objectionable advertising we are treating of than in societies devoted to other branches of engineering. Perhaps this is partly because of the scientific traditions of the profession, but probably to a greater degree it is because a great work produced by a civil engineer, such as a bridge, a viaduct, or a canal, is a unique thing of itself, which is not apt to be exactly duplicated at any other time or place, on account of conditions and requirements, topographical, financial, and otherwise. Such things are not likely to be patented even by a very mercenary engineer—and simply because there would be no profit in doing so. Another noticeable point about such productions is that they are of such a large and outdoor character that they themselves form sufficient advertisements of the man and his work. There is, however, another side to this picture, which may be seen in the numerous patents for constructive details of bridges and like structures.

Next in order we shall probably find the mining engineer, who, in the old-fashioned part of his craft, that is, strictly in mining and assaying, designs very little which could be patented, or which would be worth so protecting, for much the same reasons which exist with the civil engineer. Of course this does not apply to the mechanical contrivances and machinery proper, which modern mining requires, but in the construction of which a mining engineer has frequently to call upon a mechanical engineer for aid.



Rack-Rail Locomotive, Riggenbach System, for Brazil. Baldwin Locomotive Works.

*The above paper should have appeared in our last week's issue, but from lack of space was postponed one week. Some editorial comments on the subject discussed by Mr. SMITH will be found in our last issue.—ED. ENG. NEWS.

Next in order, in its tendency to advertise the work of its members, comes the mechanical engineering society. These men have a very natural temptation to patent their devices, because they are usually duplicated in sufficient quantities to make it a profitable investment. And the temptation to advertise them is all the stronger from the fact that such machines and devices usually pass their lives indoors in comparative retirement, and are not exposed to public view for miles across the landscape, as are bridges and embankments.

Last in the series, and guiltiest of all as an advertiser, is probably the electrical engineer. The discussions in his societies are very noticeable for descriptions of devices, originating either at home or abroad, which are covered seven times seven deep, as an onion by its skin, with layers of patents of all sorts and degrees. The reason of this it is not quite easy to see, as many of the electrical engineers are men of original research and scientific ability, with as fine professional instincts as a physician or an architect. Probably an explanation of the onion phenomenon can be partly found in the enormous activity which just at present exists in the invention and production of all sorts of devices in the comparatively new field of commercial electricity.

The writer has written more feelingly on the subject of this paper from the fact that he once was guilty of describing in detail, in an engineering society paper, a new instrument of his own invention which he soon afterwards patented. If it had been something like the telephone or phonograph, or even a successful compound locomotive, of great use to the world in spite of temporary private monopoly therein, he would of course have considered the matter all right, and would have been proud of his achievement; but as the device described was strictly within the pale of mediocrity, his conscience pricked him for having made it somewhat public through the transactions of a society. As the sequel proved, however, and fortunately for his peace of mind, the patent never brought him any profit. Thereupon he made up his mind that if such a case occurred again, he would at any rate notify the committee in charge whether a patent existed or was contemplated, that upon them might rest the responsibility.

It must not be inferred from the above that the writer would hamper free discussions upon devices embodying new and apparently valuable principles, because of the incidental advertising they would get. He would only urge a proper watchfulness on the part of publication committees against wasting the time and lowering the dignity of scientific societies by listening to mere specifications of minor devices, which should more fittingly be exploited in the newspapers.

If this paper shall succeed in drawing forth a discussion among the members of the various American Societies of Civil, Mechanical, Mining, and Electrical Engineers which shall serve in some degree to impress upon them a stronger sense of professional pride in a calling which should be truly scientific, and which will foster that *esprit du corps* which should exist among all the followers of so noble yet modest a vocation as engineering, it will have fulfilled the purpose for which it was written.

BRIDGETON, N. Y., Oct. 22, 1889.

Sandberg's New Goliath Rail and Steel Base Plate.

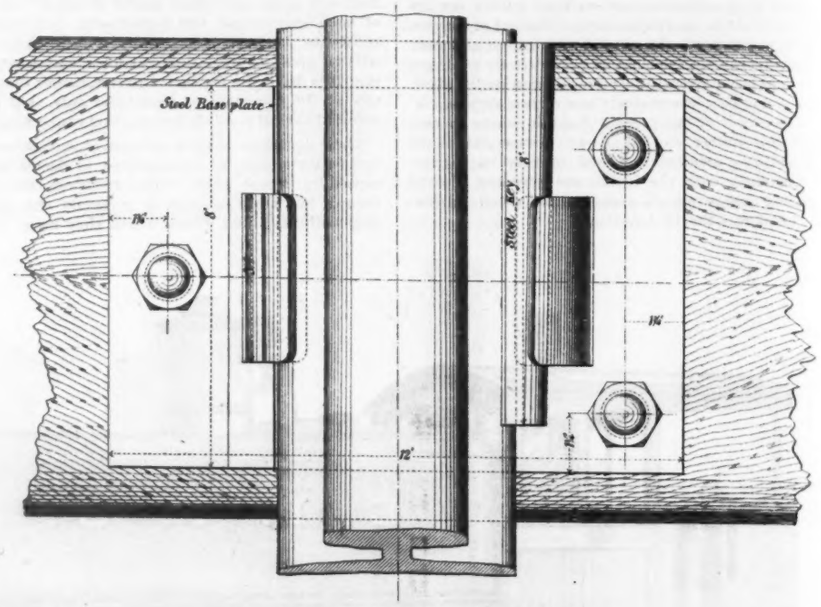
There is not at present, in one sense, any urgent call for a new Goliath rail, inasmuch as the first type was constructed only three years ago, and therefore experience with it has been, as yet, comparatively small. During that period, however, several important facts have been brought to light with respect to rail sections generally, which also affect the Goliath, and have led to the new design shown in the illustrations herewith. These facts, according to Mr. SANDBERG's memorandum, forwarded to us with these illustrations, are:

First. That the big rail head, owing to the fast rolling in the modern mills, does not seem to wear well, inasmuch as the physical hardness is only in the surface and not in the interior of the rail head. But we shall not be able to make rails chemically hard with 0.50 to 0.60 per cent. carbon, as is now used in American mills, until we in Europe, adopt the American mode of curving the rail while hot, so as not to spoil the strength of the rail by cold-straightening presses and gag-marks on the flange, which might cause fractures and accidents. It will, in any case, be better to have a wider rail head than a thicker one. The greater value of this modification will be seen not only in the greater durability of the rail, but also in the increased life of the tire, which would not require to be turned if the rail head were as wide as the bearing surface, or nearly so. It would also add to the tractive power of the engine by affording a greater bearing surface to the driving wheels; in fact, the tractive power of an engine on the wider rail head would be greater than that of an engine of equal weight on the narrower one. [This is Mr. SANDBERG's statement, not ours. We question it somewhat, and yet it may be so.—ED.]

Secondly. It would offer a better bearing for the fish joint without sloping the sides of the rail head, which has been done so largely in America, but has now been abandoned by reason of the side friction of the tire flange.

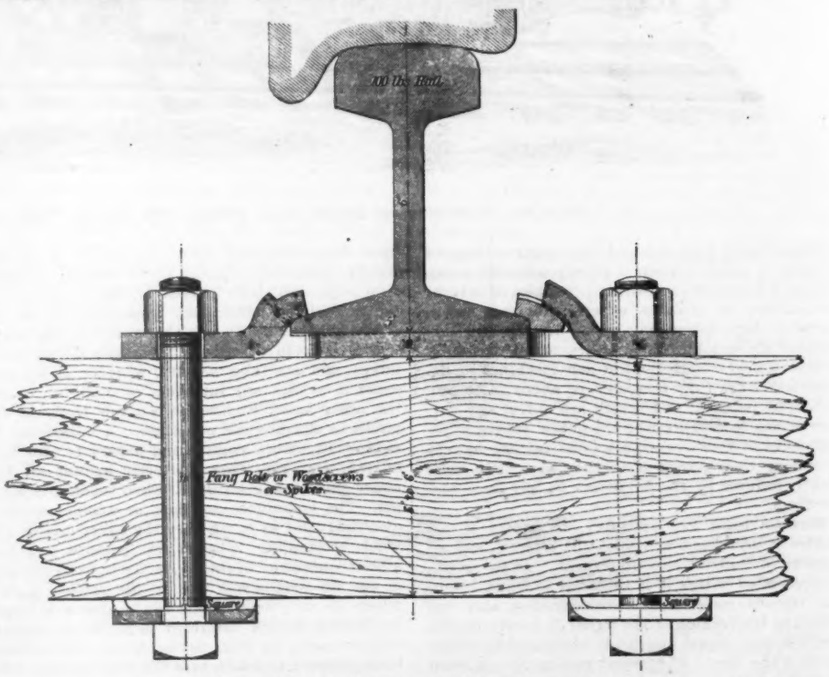
Thirdly. The crushing load of the driving tires would be less likely to exceed the limit of elasticity of the steel in the wider rail head.

These seem to be facts of very great importance, and well worthy of attention. The new Goliath rail section of 1889 has therefore been designed with a head of 3 ins. width instead of 2⅝ ins. and 1¾ ins. depth instead of 1⅞ ins., thus giving a thinner head with greater wearing surface in width instead of in depth, and giving 1 in. bearing of rail head against the fish instead of ¾ in.



Base Plate for New Goliath Rail. Plan.

The distribution of weight in the new Goliath, as compared with the old, is as follows:



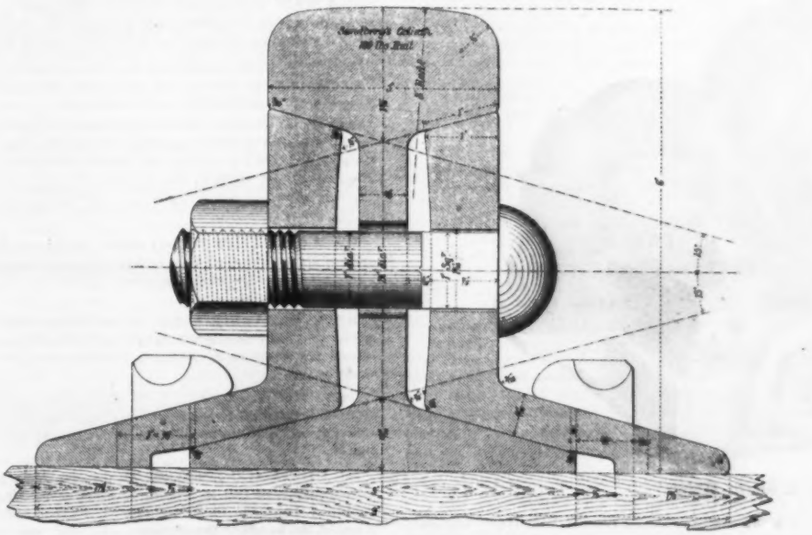
Base Plate for New Goliath Rail. Section.

	1888.	1889.
Head	43.5	45.5
Web	23.9	22.
Flange	32.6	32.5
	100.0	100.0.

Regarding the top radius, in respect to which there has been so much discussion in America with the view of not loading past the limit of elasticity,

it has been taken at 8 ins. instead of 10 ins.; it is thus made rather more rounding for the reason that the tires on old roads, where such a Goliath rail would be used, are certainly not flat, but are more or less worn hollow. By an increase of width of ⅝ or ¾ in. in the old rail head, the tire would, on curves, be brought to bear on the outside part, and thus lessen the acting depth of the tire flange by as much as it is worn hollow, so as to cause some risk of derailment, and this would be the greater the more the rail head is flat and the tire worn hollow. Therefore the 8-in. radius of rail top, which is supposed to also represent the radius of the existing wearing surface of the tire, has more chance of safety by keeping the tire on the rail, with the application of a Goliath rail 3 ins. wide to a road where 2¼-in. rails have been used.

The ¼-in. corner radius of rail head, as adopted in America, would not be applicable in Europe until the bogie system is generally adopted here as there; therefore the ⅛ in. radius is adhered to. [This also is Mr. SANDBERG'S statement, not ours. We do not believe it to be either good theory or good practice.—ED.] The vertical side is maintained as a medium between the American rail sloping inside and the Russian and German sloping outside. The lower corner radius of rail head may be as sharp as it can be rolled, say 1-32 in. The bearing of the fish, 1 in., against the rail head should be perfectly straight, and so should the fish also be, as if planed in a planing machine. This explains the changes introduced into the rail head.



New Section of Goliath Rail, 1889.

As to the flange of the new Goliath: The weak point of track laid with flange rail, as compared with bull-head rail in chairs, is the insufficient width of the base, and the weak mode of fixing the same to wooden sleepers. The width of the Goliath design of 1886, 5½ in. width of rail base, is not sufficient for pine sleepers of loose texture, as compared with 12 to 15 ins., which is what the cast-iron chair affords for the bull-head rail section. It would, therefore, be better to give up the plan of laying the rail flange directly on the sleeper, and adopt a steel plate of sufficient area, say equal to that of the cast-iron chair or nearly 100 sq. ins.,—12 x 8 and ⅛ in. thickness, might do well,—and fasten it to the sleeper with three fang bolts, wood screws or spikes, applying clips and steel keys for holding the rail to the base plate (see cuts herewith), thus enabling the rail to be made of harder steel, and affording a firm fixing of the rail to the sleeper, while by knocking out the steel keys it offers a quick means of changing either rail or sleeper when one of them becomes defective. The insufficient mode of fixing the flange rail direct to the wooden sleeper by spikes or wood screws would thus be done away with, and a longer life of the sleeper would be insured. It should be observed that the rail flange has on both sides a bearing of the whole width of base plate of 8 ins., as against the old method against a spike or a wood screw, and that the widening of gauge on curves would be arranged by using steel keys of different sizes, as in metal sleepers, of which several hundred thousand tons have now been laid in different countries with satisfactory results. Should the tilt of the rail of 1 in 20 be needed [It never ought to be.—ED.], this could be got by rolling the base plate of different thicknesses for the width of rail base. (See dotted line in drawing.) The fixing of the base plate to the sleeper is effected by means of spikes, wood screws, or fang bolts, thus giving the sleeper of soft wood a bearing surface of more than double that given when the rail is laid, without plates. This will naturally double the life of the sleeper. The extra cost of additional weight of 13 lbs. in the base plate would be covered by this saving, and the total expense of the Goliath rail track would still be less than that of a first-class English road with bull-headed rail and cast-iron chairs. If this plate is taken at $30 per ton, it would still be of less cost than the cast-iron chair, which weighs 40 to 50 lbs. and costs $12.50 to $15 per ton. By this means it might be possible to obtain as good and safe a permanent way with flange rails as with the English bull-head type of rail at a somewhat less cost. But, as is now only too often the case on the Continent, to employ half the weights of metal in the flange rail that are used in the bull-head section (with chair included), and yet to demand equal strength, is asking too much of the flange rail section.

An interesting book, called "Express Trains, English and Foreign," by FOXWELL and FARRER, just published, classes as "English express trains" all trains run at forty miles an hour or over, including stops, and as "Continental express trains" those running at twenty-nine miles an hour or over. Statistics show that in England only half the percentage of passengers are killed as compared with Continental travel. These facts speak volumes for the superiority of the English railways as compared with the Continental roads. Fortunately the price of steel has become so low that it has now become an economic advantage to use more steel to cut down the cost of maintenance and increase the public safety. To take a striking illustration, one need only compare the rail weight and the rolling stock with guns and armor plates. The guns have been gradually increased to the weight of 100 tons, and the armor plates similarly increased in thickness in equal proportion, say up to 18 ins. The rolling stock has doubled in weight and the speed been increased, but the rail has been left the same, especially the flange rail on the Continent.

The weak rail may, by stopping and patching, keep the road open under ordinary conditions; but in time of war, for instance, where the traffic is doubled or even trebled, where would the weak rail be? And what could be done to it when there is no time for patching and for repairs? The strong rail has in truth a great deal to do with the defence of a country; for the army which can, with provisions and ammunition, reach the battle-field first, stands the best chance. Experience sufficiently proved this in 1870. Thus the Goliath rail may be really a means of defence, at least in Europe.

At the Paris Exhibition there is a sufficient display of Goliath engines and carriages, but very little is exhibited to illustrate the proportionate strengthening of the road; in fact, the almost single exhibit of this kind is a series of rail models called "Goliath Rails" in the Machinery Hall (Class 16 Railway Material) showing the history of the Goliath rail, from the first drawing of 1886, the model of the same, 1887, the Belgian State Railway adoption of the Goliath section for 15,000 tons, and lastly drawings and models of the Goliath of 1889, with the addition of the large steel base plate with clips and steel keys for fixing the rail, and fang bolts, wood screws, or spikes for fixing it to the wood sleepers. 15,000 more tons of the Goliath rail have been ordered for the Belgian State railways, making 30,000 tons in all.

Levee Construction.

The following methods of construction are those adopted by the Board of Mississippi Levee Commissioners and their Chief Engineer.

The ground to be occupied by the levee must first be cleared of trees, stumps, logs, trash, weeds, and all perishable matter; the trees and stumps being cut level with the surface of the ground. The entire surface must then be thoroughly broken with a spade or plow, in order to form a bond with the earth deposited. Then a muck ditch must be cut on the river side of the center line; all stumps and roots crossing it being carefully taken out and removed beyond the base of the levee. As each section of a mile in length of the entire levee is thus cleared, broken, and ditch cut, the engineer sets the side stakes of the base of the levee; the muck ditch is then filled in with buckshot earth or clay obtained from without the base of the levee, and the earth tamped in by horses or mules, ridden rapidly back and forward constantly while the earth is being put in, or by tamping mauls, at least one horse to every ten wheelbarrows, or one tamping maul to six wheelbarrows. This filling and tamping is kept one-quarter mile in advance of the embankment. In case of repair of old levees, all stumps, logs and trees, where they are known to exist, must be dug out and the muck ditch cut near the outside base of the old levee, if considered necessary by the engineer. The surface of all old levees must be well broken. Where the chief constituent of the levee is sand, or other porous material, the engineer may require a wall of buckshot or clay, 5-ft. thick, to be continued up from the muck ditch to the top of the levee, the earth being tamped in by horses in the same manner as the muck ditch, as the levee is built up on each side of it, the object being to obtain a stratum through the levee, impervious to "sipe water." If the chief constituent of the levee is stiff buckshot or clay, the engineer may require a wall of sand 8 ft. thick, to be continued up from the surface of the muck-ditch to high water mark, as the levee is built up on each side of it, the object in this case being to obtain a perpendicular stratum through the levee impervious to crawfish.

When the ground is prepared, the embankment will be commenced: the slopes being commenced full out to the side stakes and carried regularly up. The embankment must be built one-fifth higher than the grade height marked on the stakes, to allow for shrinkage or settling.

Material is to be obtained from places designated by the engineer, and is not to be taken on the inside of the levee except upon the engineer's orders. At intervals of 100 ft. bermes must be left across the borrow pits to prevent the flow of a current along the levee. All earth for embankment must be entirely divested of roots, trash and other perishable matter before being put in place.

Where considered necessary the engineer may require a double course of sheet piling, breaking joints, to be driven at the center or either side of the levee 5 ft below the surface of the ground, and extending up to within 6 ins. of grade. The plank to be of heart red gum, white oak or cypress, and of specified dimensions. All piling is driven in advance of the levee, and the embankment con-

structed on both sides of the piling simultaneously. A breakwater may be constructed where necessary on the river slope of the levee, of post and plank wall, properly braced and filled in behind with earth. In anticipation of destructive floods during the progress of the work, a protection of timber work may be constructed around the ends of the levee, and a temporary protection levee in front of the work.

Train Lighting by Electricity in Germany.

The Zeitung des Vereins Deutches Eisenbahn Verwaltung, the official organ of the German railway administration, says that the use of the electric light is not economical in ordinary coaches; though it is no doubt suitable for Pullman trains. In 1886, Wurtemburg tried gas on through trains; but as extensive experiments with the electric light were also then being made on the State lines, the extension of gas lighting was suspended. The result of the electric light experiments has been that last year the Wurtemburg Government decided in favor of gas and appropriated 120,000 marks, or $30,000 for this purpose.

The electrical works, at Cannstatt, still maintained that electricity was the cheaper plan, and that the electrical installation for a 7-car train cost $3,000, and the cost per lamp per hour was 2.98 pfennigs (about 0.74 cts.), while other lights cost 3 pfennigs, or more. Subsequent experiments disproved this statement; and the President of the State Council, Dr. MITTNACHT, stated that experts estimated the electric installation required at $360,000, as against the Connstatt estimate of $181,000 to $250,000; and that while the electric light may cost 2.98 pfennigs per lamp hour, he knew that on the State lines gas cost only 3 pfennigs. At the new central station at Frankfort-on-the-Main, powerful petroleum reflectors are being used to supplement the electric lights, and at Hagener station, in Westphalia, gas has again replaced the newer light.

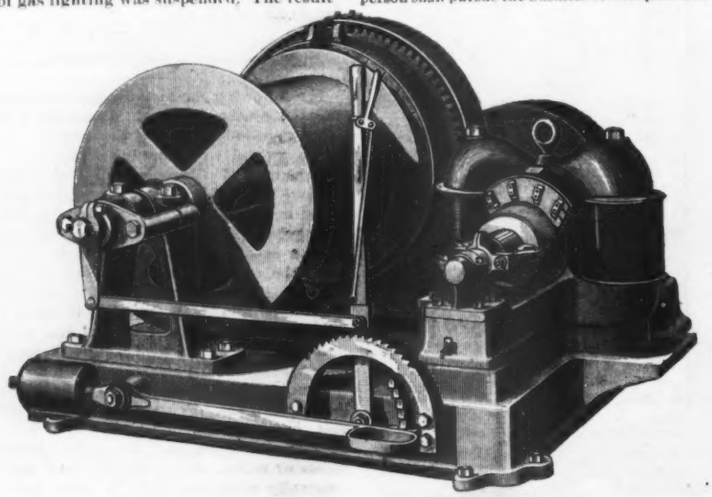
ANOTHER MISSOURI RIVER BRIDGE at Omaha, Neb., is projected. It is to be a double-track railway bridge for the use of all railways centering at Council Bluffs and Omaha which desire to run over it. A company to build it was chartered as the Nebraska Central Railway Company a year and a half ago, and has now asked for aid from Douglas County, Neb., to the amount of $250,000 on condition that the bridge shall be completed and open for traffic by June 22, 1892. Mr. J. H. DUMONT of Omaha is President of the company.

The Registration and Licensing of Architects in the State of New York.

A bill to regulate the practice of architecture in this State, and to restrict the licensing and registration of architects, was the subject of the report of a special committee at the meeting at Syracuse of the Western New York Association of Architects:

The bill provides that no person shall practise architecture in this State who has not attained the age of 21 years. It creates a Board of Architects constituted as follows: One member from the faculty of Columbia College, one from the faculty of Cornell University, two from the Western New York Association of Architects, and two from the New York Chapter of the American Institute of Architects. The bill designates the duties of the Board, and says that they shall meet at least once in six months, and serve without compensation. Under the bill no person shall practise the profession or pursue the business of an architect without a license from the Board of Architects. The Board is to examine applicants with special reference to the construction of buildings, strength of material, laws of sanitation as applied to building, and the ability of the applicant to make practical application of such knowledge in the ordinary professional work of an architect. All persons who shall be, at the date of the passage of the act, engaged in the practice of the profession in this State, shall be entitled to a license without examination on payment of $5. All licenses shall be subject to revocation by the Board of Architects for gross negligence, recklessness, or dishonest practices, but the holder shall be entitled to trial. If any person shall pursue the business or occupation of an architect in the State, or shall advertise, or put out any sign, advertisement, or card, designating himself as an architect, without first obtaining a license, he shall be deemed guilty of a misdemeanor, and upon conviction shall be fined not less than $100 nor more than $500. Nothing in the act shall be construed to prevent any person in this State from planning or supervising the erection of his own buildings, nor do the provisions of the act apply to architects from other States who may desire to compete on some special building, public or private. The fee for such license shall be $20.

The bill was referred back to the committee, with power to employ counsel, consult with the New York Association, and act for the Western Association generally.



The Sprague Electric Hoist.

The Sprague Electric Hoist.

As another proof that the use of electric power for manufactories, engineering works, shops, and mills is rapidly increasing, especially in a field for which it seems particularly adapted, where a portable and compact power producer is needed, especially in small amounts, as for operating transfer tables, turntables, traveling cranes, and various other like kinds of machinery, we illustrate herewith a new application of electric power in the Sprague electric hoist, which has recently been built by the Sprague Electric Railway & Motor Co., of New York, and is designed for use in mills, factories, miner, and other places where a constant potential electric current is obtainable, and where a simple, portable hoist is desired.

The speed of the motor is controlled by an electric switch at one side, by means of which the motor can be made to vary its speed by a single movement of the switch handle. Turning the handle to one notch will make the motor run slowly; through two notches, faster; and through the full number of notches, at full speed; while turning the handle in the opposite direction; will give similar rates of speed but with opposite direction of rotation.

The movements are so simple that no expert labor is required in handling it, an advantage which it shares with many other like electric devices and which greatly help its introduction. An ordinary machinist will soon become used to the hoist and can handle the switch and operate the motor. The machine is also compact, as will be seen from the cut, all parts being attached to the iron base frame. The gears are boxed in by removable iron cases to protect them from dust and dirt. The efficiency of the electric motor when working at full load is claimed to be over 90 per cent.; that is, more than nine-tenths of the energy delivered in the form of electric current at the terminals of the motor is said to be transformed into effective work at the armature pinion.

We understand that this is only the first of a number of special electric applications which are being prepared by the Sprague Company, which is one of the most active in this field where so many companies are now busy.

PERSONAL.

Maj. JOHN F. O'BRIEN, General Manager of the Mexican National Railway, has resigned. He has been offered two good railway positions in the United States.

Assistant Chief Engineer R. W. CLINE, of the Pennsylvania, at Harrisburg, has been elected First Vice-President of the Diamond Valley road.

Mr. M. B. CUTTER, Superintendent of the Huntington Division of the Chesapeake & Ohio Railroad, has resigned to accept a position on the Northern Pacific.

Mr. CHAS. D. MCKELVEY has been appointed General Superintendent of the New York, Susquehanna & Western.

Mr. WILLIAM HUNTER has been appointed Engineer of Maintenance of Way on the Georgia Central System. He recently held the same position on the Atlanta & West Point.

Mr. W. W. WORTHINGTON, formerly Superintendent of the Fort Wayne, Cincinnati & Louisville, has accepted the position of General Superintendent of an eastern road.

Capt. WM. T. ROSSELL, U. S. Engineers, has been appointed assistant to the Engineer Commissioner of the District, at Washington, D. C., vice Capt. SYMONS, resigned.

Mr. OLIVER GARRISON, of St. Louis, Mo., committed suicide on Oct. 28. While receiver of the Missouri Pacific he was made Vice-President of the road and took it out of the hands of the receiver. He was still Vice-President when the road was sold to Mr. JAY GOULD.

Mr. GEORGE R. CARR, General Superintendent of the Columbus, Hocking Valley & Toledo Railroad; Mr. M. P. L. BOOTH, Superintendent of the Hocking Valley Division; and Mr. W. T. SEYMOUR, Superintendent of the Toledo Division, have resigned.

Mr. J. E. PHALEN has been appointed Superintendent of the Missouri Division of the Northern Pacific, vice Mr. E. R. KNOWLTON, resigned. Mr. KNOWLTON goes with the Wisconsin Central, succeeding Division Superintendent THOS. CLIFFORD.

Mr. F. C. HILLS has been appointed General Manager of the Sioux City & Northern and Mr. J. V. MAHONEY has been appointed Traffic Manager. Mr. T. P. GERE is President.

Mr. EDWARD S. NEVINS, an engineering student of Cornell University, who lost his life last winter in attempting to save a woman who had broken through the ice, has had a memorial window dedicated to his memory in the Sage Chapel at the University. The students of the Civil Engineering Department donated the window.

BOOK REVIEWS.

State Board of Health of Massachusetts.—Twentieth Annual Report, Boston, 1889, 8vo. pp. 325, illustrations.

This is the latest issue of an unusually valuable series of State reports, treating of water supply and sewerage, food and drug inspection, mortality reports, etc. The board itself is presided over by Mr. HENRY P. WALCOTT and is composed of workers throughout, and we note with pleasure that Mr. HIRAM F. MILLS, one of the most energetic members of the board, has been reappointed for seven years from June, 1888. The engineer of the board is Mr. FREDERIC P. STEARNS, and the consulting engineer is Mr. JOSEPH P. DAVIS, both most favorably known in engineering circles.

During the past year the board has continued the work of examining the water of the various water supplies. Other experiments, having special reference to the effect upon water and upon sewage of intermittent filtration through different soils, have also been carried out.

The examination of water supplies has been carried on for nineteen months and is still in progress. The results, so far, are shortly to be presented in a tabular

form in a supplement to this report; and these results will be of the highest value. The tables contain, in addition to the chemical analyses, month by month, the statement of the most prevalent forms of animal and vegetable life, so far as they have been determined, and a general description of the source of supply, together with much important information of a general character relating to the nature and composition of water under varying conditions. The present report contains a short digest of some of this information, but it is deemed better to await the appearance of the supplement before making any general review thereof.

The experiments upon filtration of water and sewage at the Lawrence experimental station have been continued by the board with very satisfactory results. These will also be presented and discussed in the supplement in full detail. It is generally stated in the report that these experiments show that sewage can be more efficiently filtered through open sand than through sand covered with soil; because very fine material, like dust, in the upper layers of a filter prevents free access of air, and, when wet, may exclude air so completely as to render purification impossible. By allowing periods of intermission sufficiently long to dry the surface, a high degree of purification may result, but the quantity of sewage filtered is correspondingly less. The experience of last winter shows that intermittent filtration through a bed of coarse sand can be carried on through the coldest weather, when the beds are exposed to snow; but the efficiency of the beds is much reduced by such exposure and the low temperature of the sewage. By protecting the beds from snow, the experiments indicate that very complete purification can be obtained through cold weather by applying the sewage at the ordinary sewer temperature. If the beds are exposed to snow, intermittent filtration can be carried on through moderate winter weather, by using continuous filtration during the colder period.

Filtering areas of sand covered with soil, or areas of very fine sand, can be much increased in efficiency, in both winter and summer, by digging trenches in the direction of a slight incline, about 2 ft. deep, 1 ft. wide, and 6 ft. apart, and filling them with coarse sand. The sewage should be applied to this coarse sand, and about once in a month or two a half inch in depth of this sand should be removed and replaced by clean sand. In winter the trenches should be covered by boards to keep out the snow. The report gives some interesting results as obtained at these filters as to their relative efficacy in removing deleterious matter, but these will be treated more fully when the supplement appears.

Under the head of Vitality Statistics, the statement is made that the registration of births, marriages, and deaths has been conducted continuously in Massachusetts for more than 47 years by the Department of State. The Board of Health edits these reports, and notes various significant and interesting facts connected with them. The estimated population of Massachusetts in 1887 is 2,010,388, as based upon the same rate of increase between 1885 and 1887 as prevailed between 1875 and 1885. The number of births in 1887 was 53,174; or a birth-rate of 26.4 per 1,000 of the above population. This is greater than any previous year. The number of still-births (not included in above) was 1,794. The ratio of male to female births was 105.2 as compared with 105.7 for the 34 years, 1853-1886. There were 1,158 illegitimate births registered during the year; or 21.8 per 1,000 of the total births, a greater ratio than in any previous year.

There were 19,533 marriages in 1887, which is a marriage rate (persons married) of 19.4 per 1,000 of living population. This is higher than any year since 1873. The average age of the men married was 29 years, and of the women 25.5. This is the general average of the last 20 years.

The number of deaths registered for 1887 was 40,763, or 3,519 more than in 1886 and greater than in any previous year. This would indicate a death rate of 20.3 per 1,000. The increase of mortality is greater in the densely inhabitated towns and cities than in the rural districts. For the purpose of estimating the density of population, the counties of the State were divided into two groups. One of these groups consists of six counties, which contain twenty-one of the twenty-five cities of Massachusetts, and all the large cities except Worcester. This is the urban or manufacturing group. The other contains the remaining counties, and may be called the rural or agricultural group.

In the first group, with a density of 442 to each square mile in 1885, the mortality rate was 21.8 per 1,000 of living population; in the second group, with 102.0 inhabitants per square mile, the mortality rate was 18.8 per 1,000. These death rates are undoubtedly higher than the actual rate, since the population has probably maintained a rate of increase as great as that of the years immediately preceding. The 8,514 deaths of infants under one year of age, in 1887, was greater than any previous year of record.

Treating of the causes of death, the report states that there were 7,948 deaths from zymotic diseases; this is 19.5 per cent. of the total deaths, a percentage greater than that of the previous year, but less than the average for the last ten years. The deaths from constitutional diseases were 22.3 per cent. of the total deaths, or 9,104. This is less than the average. There were 17,203 deaths from local diseases, or 42.2 per cent. of the total; the average of the previous ten years being 39.6. The death rate from typhoid fever, as compared per 10,000 of the living population, show the following figures: For 1865, 13.4; 1870, 9.1; 1875, 6.4; 1880, 4.9; 1885, 3.9. The mortality from consumption was 5,871, or 14.4 per cent. of the total mortality, which is the least for any year of record.

A considerable portion of this report is devoted to the water supply and sewerage of Massachusetts towns which desire to consult with and to be advised by the board. This advice is given in detail. Food and drug inspection follows. By resolution of the Massachusetts Legislature of 1888, the board was required to investigate the presumed increased use of opium as a stimulant. The substance of their report on this subject is substantially that the medical profession is using less than in former years of this drug, and that the opium *habitués* use large and increasing quantities. Special stringent laws, regulating the sale of opium, seemed to be the generally recommended remedy, in answer to queries of the board. But in addition to this, physicians should be more careful in prescribing it and the masses should be better instructed in regard to the danger of a prolonged use of opiates. The final portion of the report includes papers on the micro-organisms in the air of the Boston City Hospital, a summary of mortality reports of Massachusetts towns and cities, and returns of water boards and companies in the State. A good index to this report is one of its excellent features, a feature usually marked by its absence in State reports as a rule.

Perspective: A Series of Elementary Lectures by ADA CONE, late Instructor in Massachusetts State Art Schools Supervisor of Drawing in Concord, N. H., Public Schools, and Lecturer on Industrial Art to Teachers' Institutes; Pupil Museum of Fine Arts, Boston. New York: W. T. COMSTOCK. One 12mo. vol., cloth, 62 pp. Price, $1.

This little book has much more merit than the average elementary manual on perspective. The diagrams are well drawn, and are placed as near as possible to the text that refers to them, instead of being printed (as they too often are) in cumbersome plates at the end of the book. The explanations are clear, and the judicious arrangement of the text shows the familiarity of the author with her subject. In so small a space it was of course impossible to give a number of examples, but the principles laid down and explained, if intelligently applied, are sufficient to enable the student to work out any ordinary problem in perspective.

The writer gives excellent advice when she urges on students the necessity for working out problems for themselves, and proving the theories by actual practice and observation. She says: "It is comparatively easy to comprehend a subject in the abstract, but abstract knowledge of perspective is not enough for the artist. He must, in homely metaphor, eat, drink, and sleep with it." But she gives no advice as to the best methods of practically demonstrating the rules laid down, and of satisfying the mind of the truths of perspective. Some general directions on this subject would perhaps have been more useful than the part of the work taken up with the perspective of flowers.

PUBLICATIONS RECEIVED.

—*Steam Plants for Electrical Service.*—Illustrated Catalogue of the Pond Engineering Co., St. Louis, Mo. Engines, boilers, pumps and appurtenances for complete plants for driving dynamos. 22 pp., 5¼ x 7¼ ins.

—*The Roney Mechanical Stoker.* Illustrated pamphlet 10¾ x 7½ ins., 32 pp. Westinghouse, Church, Kerr & Co., New York and Pittsburg.

This is a well arranged and well printed pamphlet describing the Roney mechanical stoker and smokeless furnace, for the economical handling and complete combustion of all kinds of soft coal, screenings and cheap fuel in general. W. R. RONEY is the patenter of this device, which is already in extensive service under the Hazelton tripod boiler and other boilers.

—*Proceedings of the General Time Convention*, held Oct. 9, 1889. Pamphlet 7 x 10 ins., 30 pp. Published by the Convention; price $1.60. Copies may be obtained of the Secretary, W. F. ALLEN, 46 Bond St., New York City.

A report of the most important business transacted at this meeting was given in our issue of Oct. 12. The most of the time of the Convention was given up to the Car Service question. The Appendix contains the recommended forms, etc., for the use of local Car Service associations. The whole matter is to come up for final discussion and settlement at the meeting to be held in this city next April.

—*Annual Report of the Commissioner of Railroads and Telegraphs of Ohio*, for the year 1888, W. S. CAPELLER, *Commissioner*, 7 x 10 ins. 1113 p.p., cloth bound.

—*Report of Proceedings of the New York Railroad Club* at the monthly meeting Oct. 21, 1889.

This pamphlet contains the discussion on "Axles, Journal Bearing, Boxes and Lubrication," which was mainly in relation to the Meneely roller bearing for cars.

SOCIETY PROCEEDINGS.

American Society of Civil Engineers.—The regular meeting was held Nov. 6; Vice-President A. FTELEY in the chair.

An illuminated copy of the address of welcome delivered in June last by Sir JOHN COODE, President of the Institution of Civil Engineers, was received from the Institution. On motion of Mr. EMERY a committee was appointed to acknowledge the gift. A communication was received from the American Institute of Mining Engineers in regard to the meeting of the Iron and Steel Institute, of Great Britain, to be held in this country in the fall of 1890.

The Committee on Revision of the Constitution reported progress, and stated that the time was too short and the subject too important to allow of a final report being presented at the annual meeting in January as called for. The committee, however, made the important step of recommending a complete codification or rearrangement of the present much mixed constitution and by-laws, with the purpose of securing a more intelligent basis for future amendment. An amendment was also offered by the committee tending to hasten the time of action on a new Constitution. The recommendations were accepted and the committee continued, to report at the business meeting of the annual convention next summer.

Mr. CHAS. E. EMERY read an interesting paper describing a visit to the great Forth Bridge in Scotland.

The following candidates were elected:

MEMBERS.

BOLTON W. DECOURCY, Architect and Civ. Eng., Port Townsend, Wash.

JOHN O. JAMIESON, Div. Eng., O. Ry. & Nav. Co. Portland, Ore.

WM. W. KENLY, Eng. of Const., Edge Moor Bridge Works, Wilmington, Del.

JUNIORS.

WM. F. BEHRENS, Asst. Eng., Atl. & Pac. R. R., Albuquerque, N. M.

M. C. HAMILTON, Asst. Eng. Asylum St. Impt., Hartford, Conn.

GEORGE W. SHERWOOD, Instructor of Civ. Eng., Lehigh University, Bethlehem, Pa.

Engineers' Club of St. Louis.—A meeting was held Oct. 23; President MEIER in the chair; 28 members and 2 visitors present.

The Secretary read a letter from the chairman of the Board of Managers of the Association of Engineering Societies, proposing a meeting of the board to consider the question of proposed affiliation with the American Society of Civil Engineers. Prof. JOHNSON stated that this announcement was made for the club's information in order that an opportunity might be given the club to instruct its members of the board regarding some plan of united action.

Mr. H. A. WHEELER then presented some notes regarding the recent European trip of the American engineers.

Prof. JOHNSON exhibited a test piece of iron, which had been welded by the electrical process at the exposition, after which the meeting adjourned.

WM. H. BRYAN, *Secretary.*

The Civil Engineering Society of the Massachusetts Institute of Technology has issued a copy of its Constitution and By-laws under date of October, 1889. The officers for 1889 are—President, F. W. RANNO, '89; Vice-President, R. L. RUSSEL, '89; Secretary, H. B. BURLEY, '90; Treasurer, F. KNIGHT, '90.

American Society of Mechanical Engineers.—The next meeting will be held in New York, Nov. 18th to 22d. A reception will be held Nov. 18th at the new rooms of the Society, 64 Madison Ave. The following papers will be presented: Nov. 19: "Properties of the Vapor of Water," V. DWELSHAUVERS-DERY; "Theory and Design of Chambers," H. R. GALE; "Philosophy of Multiple Cylinder or Compound Engines," R. J. THURSTON; "Flow of Steam through Orifices" and "Experimental Study of the Different Types of Calorimeters," C. H. PEABODY; "Cost of Lubricating Car Journals," L. S. RANDOLPH; "Steam Pipes for Collieries," E. F. C. DAVIS; "Rolling Steel Rails," D. K. NICHOLSON; "Methods of Reducing the Fire Loss," C. J. H. WOODBURY.

Nov. 21, "Indicator Rigging for Compound Engines," F. W. PARSONS; "A New Recording Pressure Gauge," W. H. BRISTOL; "General Solution of the Transmission of Force in a Steam Engine," D. S. JACOBUS; "Street Railway Car Gear for Modern Speeds," S. J. MCFARREN; "The Comparison of Indicators," F. B. WEBB; "The Cards from the Pawtucket Pumping Engine with and without Jacket," J. E. DENTON; "How to use Steam Expansively in Direct Acting Pumps," J. T. HOLLOWAY; "Cost of Steam and Water Power," C. T. MAIN; "Graphical Analysis of Reciprocating Motors," OBERLIN SMITH.

On Nov. 20 there will be an excursion. On Nov. 22 there will be a trip on the new double screw ferry-boat, *Bergen*, and a paper on "The Performance of a Double Screw Ferry-Boat," will be presented by Prof. J. E. DENTON and Col. E. A. STEVENS.

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GEO. H. FROST . . . . . BUSINESS MANAGER

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Coming Technical Meetings.

New England Railway Club, Boston, Mass.—Next meeting, Nov. 13. Discussion on "Journals and Journal Bearings." Rooms in the United States Hotel.

Civil Engineering Society (Inst. of Technology), Boston, Mass.—Next meeting, Nov. 14. Secy., Clement March.

Engineers' Club of Philadelphia, Pa.—Next meeting, Nov. 16. Secy., Howard Murphy, 1122 Girard St.

American Society of Mechanical Engineers, New York.—Next meeting, Nov. 18 to 22. Secy., F. R. Hutton, 64 Madison Ave.

Western Railway Club, Chicago, Ill.—Next meeting, Nov. 19. Rooms in the Phœnix Building.

Engineers' Society of Western Pennsylvania.—Next meeting, Nov. 19. Secy., S. M. Wickersham, Pittsburg, Pa.

Engineers' Club of St. Louis, Mo.—Next meeting, Nov. 20.

American Society of Civil Engineers, New York.—Next meeting, Nov. 20. "Formulæ for the Flow of Water in Pipes," E. B. Weston. Secy., John Bogart, 127 E. 23d St.

Boston Society of Civil Engineers.—Next meeting, Nov. 20. Secy., S. E. Tinkham, City Hall.

New York Railway Club.—Next meeting, Nov. 21. Rooms at 113 Liberty St.

Engineers' Club of Kansas City, Mo.—Next meeting, Dec. 2. "Snow Plows," F. E. Sickels. Secy., Kenneth Allen, 200 Baird Building.

Western Society of Engineers, Chicago, Ill.—Next meeting, Dec. 4. Secy., J. W. Weston, 78 La Salle St.

Association of Civil Engineers, Dallas, Tex.—Next regular meeting, Dec. 6. Secy., E. K. Smoot, Elm and Austin Sts.

Civil Engineers' Club, Cleveland, O.—Next meeting, Dec. 9. Secy., C. O. Palmer, 21 Cedar Ave.

It begins to look very much as if the foolish action of the Site Committee in listening overmuch to the buzzing swarm of real-estate agents, who, like the two tailors of Tooley St., did not hesitate to pose as "we, the people of New York," and so persuaded them to report that Central Park was just the place for a fair, had killed all chance for there being a fair at New York on any site. The only way to carry through so great an enterprise in any city is to place it on a basis which both convinces the judgment and kindles the imagination of the average citizen; and the recommendation of an unattainable site and unoriginal buildings does neither the one nor the other. The $5,000,000 subscription has grown after two weeks' effort to a little over half of the required amount and has greatly fallen off in rate of increase. Whether the proposed total be finally secured or not—and it probably will be, for it is a mere bagatelle for New York to subscribe—the way in which it has been subscribed shows indifference or animosity on the part of a large section of the public,—an indifference which is caused, not alone we may safely surmise, by disapproval of what has been already done, but also by fear of what may yet be done, after such a beginning. In any true sense of the word, the site selected is not even the most accessible, and that the most important of all the committees (for the present at least) should have so promptly tied itself up in a knot by selecting, to the exclusion of all others, the site which was at once the most difficult to secure, the most likely to create opposition, and the most certain to cause suspicion that private and not public interests had impelled the choice, is not a hopeful augury of what might happen as the project advanced to fruition.

The story which was given such wide circulation in the daily press last week that either the Union Pacific or parties identified with the VANDERBILT interests had secured control of the Chicago & Alton Company—seems to have been made up on about the same basis as the reports of various other railway deals, which have served to fill space in the daily papers of late, until the election returns crowded them out. The actual conclusion of the Chicago & Northwestern and Union Pacific alliance served as foundation to build stories of many other deals upon; and the rumor-mongers have improved their opportunity. On the other hand, it is certainly true that negotiations for various alliances and consolidations are now going on; and while consolidation is not to proceed at any such rate as the reporters for the daily press affirm, it will proceed all the same, and quite rapidly enough for the good of all concerned.

There is one fact with regard to these various alliances and counter-alliances, however, which does not seem to be generally realized. By the enactment of the Interstate Commerce law, the alliances, traffic contracts, and schemes for competition and for meeting competition, which had been vitally important under the old régime, were made comparatively unimportant and ineffective. Section 3 of the law provides that:

> Every common carrier subject to the provisions of this act shall afford all reasonable, proper, and *equal* facilities for the interchange of traffic between their respective lines and for receiving, forwarding, and delivering of passengers and property to and from their several lines and those connecting therewith, and shall not discriminate in their rates between such connecting lines.

In brief, every railway company is forbidden by law to show any more favor to its allies than to its enemies. Non-discrimination toward other common carriers is as certainly required as is non-discrimination between freight shippers. Of course, there is great room for evasion of this statutory requirement, and a railway company can certainly show many favors to an allied company in a quiet way without making itself liable to penalties; but the discrimination can never approach that existing in former times, which often made a company's plots and counter-plots, its strong alliances and counter-alliances, the most potent causes of success or failure.

VIEWED in this light, it will be seen what a comparatively trivial matter to other companies is the recent traffic contract between the Chicago & Northwestern and the Union Pacific. Some of the Western journals which seem to have an unaccountable malice against the Interstate Commerce Railway Association have magnified this traffic contract into an occasion for a wholesale rate war, and have predicted the complete downfall of the Interstate Association as the first step in the fight. It is enough to say that the continued publication of this report, if many people gave credence to it, would be worth enormous sums to the operators on the bear side of the stock market. If the managers of the Western railways keep their senses, and wish to keep their positions, the Interstate Commerce Railway Association will not fail from causes so unimportant.

THE city of Providence, R. I., is just now afflicted with an obstructionist in the shape of a Commissioner of Public Works who is personally opposed to the improved sewerage plans lately adopted in that city. This Commissioner succeeded a Board of Public Works that was abolished because it would not work in harmony with the engineering department; but, according to the press accounts, he now concentrates in himself all the hostility of the old board towards the city engineer and is using every means in his power to defeat the GRAY sewerage plan. With little or no reputation or experience as a civil engineer, this official has the presumption to change contract and specifications, and to push plans of his own against those of an engineer familiar by long years of service with every detail of the local conditions, and against a plan approved by a special board of engineering experts, adopted by the city authorities, and ordered to be at once constructed upon the plans and under the direct supervision of City Engineer GRAY, who is by law made personally responsible for its execution. Providence is singularly fortunate among American cities in having its engineering work all under the control of one competent engineer, who is clothed with the powers usually divided among the many heads of distinct, and often conflicting, departments. Much is saved in salaries by this system and better work is performed than where the authority is divided. The law in the case seems plainly enough to give the engineer all necessary power; but the Commissioner of Public Works sees fit to interpret this law to suit his own purpose in a manner that is puzzling to outsiders. The controversy has now assumed such a shape that the legal authorities of the city have been called upon to exactly define, once for all, the status of the two officials, and the matter is now in their hands.

IT will be very unfortunate for Providence if, by any legal quibble, the true intent of the law can be twisted to the extent of supporting in any degree the claims of this Commissioner. The effect of such a ruling would be to once again sink in the political mire the execution of its public works and to put their control out of the only hands competent to serve well the interests of the city and insure their honest and proper completion. The present organization of the engineering department of Providence is vastly in advance of the usual practice in this country, and this department has been so successfully administered in the past that any attempt at a step backward should be most emphatically condemned by the city authorities, especially when opposition, based upon purely personal motives, is delaying the execution of a greatly

needed public improvement. To separate works of this character from outside political control and to make the engineer the actual master of all engineering works, untrammeled by outside influences, is a practice that is not in favor in our great cities; but it is a practice that every citizen who has the true interests of his city at heart should support by every means in his power, just because there is another class which sees personal and party gain in eliminating the engineer and substituting for him the politician. The rule of the professional politician seldom means the good of the community, as too many of us well know.

We have received from one of the Consul-Generals of this city the following note:

I am ordered by my home authorities, who endeavor to insure the general public in the best way possible against any harm arising from street railways, to obtain descriptions and designs of new and reliable safety appliances and improved brakes used on horse, cable, and electric cars in large cities of this country. If you can favor me with some of such designs and descriptions you will greatly oblige.

As the surest and fairest way of giving every one a chance in this matter, we publish the note herewith for the information of all interested, and will only add that if proprietors of any devices which have stood the test of experience and appear to come within the scope of this request will communicate with us, we shall be pleased in our turn to do what seems warranted to bring their devices favorably before the author of the above note.

The preposterous Indiana natural gas law, attempting to forbid the exportation of natural gas to points without the State, has been quashed by the Indiana Supreme Court as unconstitutional, as it was sure to be; and the work of piping gas from the Kokomo district to Chicago, 110 miles, will now, it is expected, proceed rapidly. The company has 27,000 acres of gas land, its surveys all made, and its capital all raised, and it is expected that not more than one or two pumping stations will be necessary, so that there is ground for hope that the price of gas will be low, and that Chicago will get rid of a part at least of its intolerable smoke nuisance, which is highly discreditable to the city in that much of it is wholly needless. If the buildings and factories were compelled to use the fairly effective smoke-consuming devices which already exist, and if the tugs and locomotives were compelled to burn either anthracite coal or coke, the smoke nuisance of Chicago would be practically overcome even without the aid of natural gas. Should the hope of securing the Exposition stir up Chicago to rid itself of this easily cured and hence entirely inexcusable nuisance, the money profit from the Fair will be a trifling benefit in comparison.

In noticing the standard frame trestle used on the Cleveland & Canton R. R., in our last issue, we unintentionally omitted to state that we were indebted for the drawing and description to Mr. Walcott C. Foster, C. E. And we would further state that it was an abstract from his forthcoming work on "Wooden Trestle Bridges," an excellent exhibit of the varied practice in this direction, as far as we have had an opportunity to examine the material.

The Legal Status of "End-Area" Earthwork Computations.

A correspondent in another column, Mr. Archibald A. Schenk, makes a query which we must confess we are unable to answer, viz., "whether the 'end-area' method of calculation is allowed by statute in any of the States, as has been claimed; and whether custom could compel its use in case of dispute." If any of our readers are in a position to give precise information as to the status of this question in the United States as a whole, or in any State, and no doubt many of them are, we shall be pleased to have them communicate the facts to us. In the meantime, it may be well for us to briefly outline what we understand to be the legal aspects of the question, and the present state of practice.

We anticipate that if an accurate census could be taken, it would be found that at least nine-tenths of all the earthwork computations made on this continent are made by the simple process of averaging the end-areas and multiplying by the length for the volume, and we will go further and say that nine-tenths of the individual solids ought to be so computed, although the remaining tenth would include many solids now computed by end-areas, but which ought not to be so computed. If, therefore, it was possible for "custom to compel the use" of the method of averaging end areas, or rather, if the case were one where the conditions were so uniform that the custom in one place or State could fairly be taken as establishing a precedent for all cases, the method of end-areas would be established on an impregnable basis. For example, if it were shown that the method always involved a certain excess of quantities, ranging say from 2 to 8 per cent., and averaging about 5 per cent., and it were shown also (as we have stated is the fact) that the method was in almost universal use for computing earthwork, a contractor could undoubtedly establish by the Common Law his right to have his earthwork measured in this way, failing proof that there had been some prior notice or agreement that it would be measured in some other way. The fact that his contract read "per cubic yard," and that the method did not give the true number of cubic yards, but always a certain reasonably constant ratio of excess, would not count against him, for a court would surely interpret "per cubic yard" as meaning per cubic yard measured in the usual and customary way.

Such, however, are not at all the real conditions. The method of averaging end-areas does not always give too large a solidity. It sometimes gives too small a solidity. On tens of thousands of miles of railway which have been built in this country the error in using the simpler method is so small that it does not amount to nearly one-half of 1 per cent. On a few thousand miles it would naturally amount to considerably over 1 per cent., but even in this case it depends not at all upon the configuration of the country, but wholly upon who does the cross-sectioning, whether the error amounts to 5.0 per cent. or 0.05 per cent. Therefore, under no conditions does a contractor enjoy any assurance of gaining a substantial advantage from this rougher method of computation, as he does, for example, from the rule of measuring in all small openings as part of the contents of a wall; which latter custom has been again and again decided binding by the courts, simply on the ground of common practice, although not distinctly specified in a contract.

In these last facts we have the reason why no amount of preponderance of practice in the use of the end-area method can give a contractor any claim to insist upon having that method used in determining his quantities. If it worked uniformly and sensibly in his favor, his claim would be at this moment perfect to have it used in every case where there was no prior stipulation to the contrary; but as it depends in every case solely upon how close together the sections are taken whether there is any sensible error at all, it is impossible that any man should acquire a right to have his quantities computed in that way, and we do not believe that even a State law that he should, could be maintained before the courts; because it must always be open to any man to take fewer cross-sections, compute the volumes correctly, and thus obtain a result practically identical with that given by more frequent cross-sections and the simpler process of computation.

For example, let us suppose a piece of work on which the successive cross-sections were practically level, but the center heights, when taken 100 ft. apart, differed 5 ft. If the slopes were 1½ to 1, whatever the road-bed, the error in excess on each solid would be exactly 23.1 cu. yds., the end-area volume of the solid, if averaging 5 ft. depth, being 425.9 cu. yds. (18 ft. road-bed). If on the same solid the cross-sections were taken only 20 ft. apart, the error per solid would be only $\frac{1}{5}$ part as great, or 0.9 cu. yds. and the total for the 100 ft. only 4.5 cu. yds., an error by no means so great as the errors resulting from imperfections of the field-work and grading, and hence leaving only a reasonable margin in favor of the contractor. But if this be thought too great, if the sections were only 10 ft. apart, the error would be only one-fourth as much as the last again, or 1¼ cu. yds. on the solid. What law or custom can compel a man to take cross-sections ten times as close together as is otherwise necessary, in order that he may apply an incorrect formula to them, if he testifies that his intention was to use the more correct method of computation when he took his section less frequently? There is lacking the essential element of an expectation of advantage founded upon past experience, to entitle the contractor to insist on it, because only by gross negligence or ignorance on the part of the engineer can he ever have enjoyed in the past any sensible advantage from the end-area method.

On the other hand, the contractor has a right to protest against the use of any of the methods for reducing cross-sections to an "equivalent level section" before applying the prismoidal formula, for the reason that these methods of transformation, in all their varied forms, while more correct than end-areas as respects each single solid, introduce a cumulative error in deficiency, which exists in every solid, and hence on a long division will amount to several hundred cubic yards, always against the contractor. These methods, therefore, being at once laborious and very objectionably inaccurate, ought never to be used.

The exact difference between the end-area and the true prismoidal volume of any "three-level" railway solid, as it is called, that is, one defined by center and side stakes only, and having the road-bed and slopes constant, is given by the formula,

$$C = (c-c')(D-D')\frac{l}{12} \qquad (1)$$

in which c and c' = the center heights, D and D' = the horizontal distance between extreme slope stakes, l = the axial length of the solid, and C = the required difference or correction in cubic feet. For corrections in cubic yards and solids 100 ft. long, this reduces to the form:

$$C = \frac{c-c'}{3.24}(D-D') \qquad (2)$$

If the sections be level sections, we have:

$$(D-D') = 2s(c-c') \qquad (3)$$

in which s = the rate of slope, usually 1½. Calling it 1½, we obtain from equations (2) and (3):

$$C = \frac{(c-c')^2}{1.08} \qquad (4)$$

The table given below, which will be shortly explained, is a tabulation of this formula. It will be apparent from these equations that

the error of the end-area method is quite independent of the particular volume of the solid, of the width of road-bed, precise form of surface, and depth of cuttings, but depends solely on the *difference* between the center heights or distances out. Therefore, in order to eliminate all sensible error from the method of end-areas, the sole requirement is to take cross-sections so frequently as to make these differences small. It will be apparent from the form of Equation (2) that if either $c = c'$ or $D = D'$ the equation reduces to zero, that is, the end-area volume is correct, although the sections may otherwise differ considerably and so have quite different areas. But as sections of different areas will always have a different "equivalent level center-height," if we take the trouble of reducing to level center-height we are actually doing extra work in order to introduce a source of error. Again, if we happen to have a solid, one end-section of which has a disproportionately deep or shallow center height, we may chance to have in the solid:

$c > c'$ and at the same time $D < D'$

This method being rejected, then, and also the common substitute of reducing to level section, what remains?

Fortunately, there remains at once the simplest and the most accurate method of computing by the prismoidal formula, that known as the "Method of Center Heights," which is this: Compute all the volumes by end areas in the usual manner. These volumes will answer every purpose for preliminary and monthly estimates. Then, at any time before a final estimate, look over the center heights, and determine which of them differ more than 2 or 3 ft. from each other. For all solids in which they do not so differ, the end-area volumes are near enough. For all solids in which they do so differ, subtract the center heights from each other, and *for the purpose only of determining a correction* regard the sections as level sections of their actual center heights, when Equation (4) will give the error, and consequently the correction to be applied to ascertain the true volume under this assumption. Equation (4) may be tabulated in a very brief table, which is given

TABLE OF PRISMOIDAL CORRECTIONS FOR END-AREA SOLIDITIES.

Giving all that is necessary for converting end-area solidities of regular or irregular railway earthwork excavated with any constant roadbed and 1½ to 1 side slopes into the most accurate approximation to the true volume of a series of solids which it is possible to attain by any method whatever.

RULE. Deduct the actual end center heights of each successive solid from each other and take from the table corresponding correction. If the solid be more or less than 100 ft. long, multiply the correction obtained from the table by the decimal length of the solid in stations for the true correction. Add the corrections thus obtained for the total solids of a cut or section, and deduct them in gross from the total end-area solidities.

Diff. Cent. Heights	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
1.0	0.0	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7
1.0	0.9	1.1	1.3	1.6	1.8	2.1	2.4	2.7	3.0	3.3
2.0	3.7	4.1	4.4	4.9	5.3	5.8	6.3	6.7	7.3	7.8
3.0	8.3	8.9	9.4	10.1	10.7	11.3	12.0	12.7	13.4	14.1
4.0	14.8	15.6	16.3	17.1	17.9	18.7	19.6	20.4	21.3	22.2
5.0	23.1	24.1	25.0	26.0	27.0	28.0	29.0	30.1	31.1	32.2
6.0	33.3	34.4	35.6	36.7	37.9	39.1	40.3	41.6	42.8	44.1
7.0	45.4	46.7	48.0	49.3	50.7	52.1	53.4	54.9	56.3	57.8
8.0	59.3	60.7	62.3	63.8	65.3	66.9	68.4	70.1	71.7	73.3
9.0	75.0	76.7	78.4	80.1	81.8	83.6	85.3	87.1	88.9	90.7
10.0	92.6	94.4	96.3	98.2	100.1	102.1	104.0	106.0	108.0	110.0
11.0	112.0	114.1	116.1	118.2	120.3	122.4	124.6	126.7	128.9	131.1
12.0	133.3	135.6	137.8	140.1	142.4	144.7	147.0	149.3	151.7	154.1
13.0	156.4	158.9	161.3	163.8	166.3	168.7	171.3	173.8	176.3	178.9
14.0	181.4	184.1	186.7	189.3	192.0	194.7	197.4	200.1	202.8	205.6
15.0	208.3	211.1	213.9	216.7	219.6	222.4	225.3	228.2	231.1	234.1
16.0	237.0	240.0	243.0	246.0	249.0	252.1	255.1	258.2	261.3	264.4
17.0	267.6	270.7	273.9	277.1	280.3	283.6	286.8	290.1	293.4	296.7
18.0	300.0	303.3	306.7	310.1	313.4	316.9	320.3	323.8	327.3	330.7
19.0	334.3	337.8	341.3	344.9	348.4	352.1	355.7	359.3	363.0	366.7
20.0	370.4	374.1	377.8	381.6	385.3	389.1	392.9	396.7	400.6	404.4

In this case the end-area volume itself will actually be too small, while reducing to level section will still further decrease it. Such solids are scarce, but those with equal or nearly equal center heights or distances out less so, while every solid in which there is any deviation from a perfect plane in the surface slope is computed too small by the equivalent level section method, its equation of error being:

$$C_1 = (\sqrt{cD} - \sqrt{c'D'})^2 \frac{1}{12}$$

For this equation to reduce to zero we must have

$$\frac{c}{D} = \frac{c'}{D'}$$

In other words, the surface must be a plane to make reducing to level section give an accurate result.

When the solids are irregular in surface, that is, defined by more than three levels, Equation (2) does not directly apply, and the true volume must be determined—if it is to be determined at all precisely—by the actual interpolation of a theoretical mid-section, constructed by taking the half sum of all the corresponding dimensions of the two end sections. To do this is so laborious a process that it is practically never done, and it never ought to be done. It would be cheaper to take cross sections in the field every 5 or 10 ft. above in order to make this article complete, extending up to 20 ft. difference of center heights, although 10 ft. is the extreme limit for reasonably careful cross sectioning.

By this method the additional labor of determining true volumes by the prismoidal formula is too slight to be considered, while actual trial on long series of solids shows it to give a more exact approximation to the true volume than is attainable by any other method whatever, what error there is being a slight excess in favor of the contractor, as it should be. The theory of the method is that all the regular part of the section—all that below its actual center height if the section were leveled off—shall be computed precisely, which includes fully 95 per cent. of a long series of sections, while the irregular part, along the surface, is left to be computed by end-areas, which give a trifling margin in favor of the contractor instead of against him. In fact, as the cross-sectioning of this part of the work usually tends to give too small volumes, owing to the crowning of the surface being neglected, the nominal margin is probably often, if not always, non-existent.

To illustrate the workings of this rule, let us assume an extreme case, 20 ft. and 25 ft. center height, surface slope of 20°, and road-bed of 18 ft. 1½ to 1. The areas of these sections will then be 1389.26 and 1997.73 sq. ft. respectively, giving an end area solidity of 6272.20 cu. yds. Subtracting the actual center heights, we have $25 - 20 = 5.0$ ft. difference, the corresponding correction being 23.1 cu. yds., giving as the volume 6249.10 cu. yds. If we reduce to equivalent level section, we obtain 30.97 and 26.02 ft. respectively, and $30.97 - 26.02 = 5.95$ ft. as the difference. Entering the table with this we obtain 32.7 cu. yds. as the correction, or 6239.50 cu. yds. as the volume, which in this case is correct, as the surface is by assumption a perfect plane; otherwise we should have had to interpolate a mid-section to get the true volume, which would have been larger than that last obtained. But although this example shows a nominal error of 9.6 cu. yds. in excess in the "Method of Center Heights," yet the case is an extreme one, and on any such actual solid, the chances would be ten to one that the large volume would be the nearer to the truth, owing to neglected curves of the surface, while the error is only 0.14 of 1 per cent. any way, and far within the probable limit of accuracy.

No contractor can establish in court any right to object to this mode of applying the prismoidal formula, therefore he can most reasonably object to what is still perhaps the most common mode, reducing to level section; for he may with perfect justice insist that no method of computation which leans constantly against him, by however small an amount, should be employed. An engineer who had properly cross-sectioned his work could probably establish against a complaining employer his right to compute by end-areas; but that any contractor could compel an engineer to compute his quantities by end-areas if he swore that he had cross-sectioned with a view to the more accurate formulæ which yet leaned in favor of the contractor if at all, we do not believe, even in the face of State laws asserting as much. No law working palpable and irregular injustice will hold in the courts; at least, it should not. If it provided for legalizing a certain customary percentage of advantage, it would be different.

The English Railway Clearing House.

In a short letter published in our correspondence column last week, Mr. ALDACE F. WALKER refers to the Railway Clearing House of England as the model on which traffic associations in this country will eventually be conducted, and says that the recognition and legal authorization which are given to the English Clearing House are necessary to the successful working of the traffic associations of this country. Much has been said of late concerning the English clearing-house; and while our space will permit no extended description of this organization, which is so important a factor in British railway traffic, a brief outline of its general method of working may interest our readers.

In some of its important features the clearing-house is similar to the institutions of the same name which balance the credit and debit accounts of the several banks in a city; but the railway clearing-house is an institution of much broader powers and duties than the clearing-house of the banks.

Broadly speaking, it has charge of all the traffic of every sort in which two or more railway companies are jointly interested. All the ticket sellers and freight agents of every company are required to make regular returns to the clearing-house of all tickets sold or freight shipped and also of all freight received, etc. From these complete returns the clearing-house makes up the accounts of the various companies, allotting to each its due pro-

portion of the total amount received for the shipment or journey, and charging to the company which has collected the freight charge or the fare the proper amount. In this way it is easy to determine at regular intervals how the accounts of the various companies stand with each other and the balances which may be due from certain of the companies to each of the other companies. By Act of Parliament in 1850 these decisions of the clearing-house have the force and effect of a judgment in a court of law; and the balances which the clearing-house finds due, therefore, are always promptly paid.

Only experienced railway accountants can realize the magnitude of the task involved in collecting and compiling these traffic returns, covering such a vast multitude of transactions, and finding from them the actual balances due. But great as the work is, it is much less than would be the case if each company, as in this country, kept accounts with all other companies with which traffic is interchanged. It is also to be noted that the common frauds of underbilling, overbilling, and fraudulent invoicing are by this system made practically impossible. A check is also provided against the practice of fraud upon a company by its own agents.

Another department of the clearing house is concerned with the car mileage statistics. By a staff of over 400 men, known as "number takers," a record is kept of the movements of practically every piece of rolling stock in England whenever it is off the premises of its owners. The time during which it is detained at any point for longer than the allowed time is also shown infallibly by the records, and from them the demurrage charges against each company are made up.

In considering the magnitude of the work done by the clearing-house, the complications arising from the various traffic agreements which the different companies have with each other must be remembered. Then there are the claims arising from goods lost, delayed, or damaged in shipment, the terminal charges and the charge for collections, charges for cartage at either or both ends of the route, all of which have to be properly entered in the accounts of the respective companies. To carry on this work over 1,500 clerks are employed at the head office in London, while over 400 men are engaged outside as "number takers," etc.

The work of other departments of this organization, the lost baggage department, the "parcels" department, etc., are sufficiently described by their names. As regards the fixing of competitive rates, the work of the clearing-house is similar to that of American traffic associations. The general managers of the associated companies meet quarterly and arrange through rates, make traffic contracts, etc. It is, of course, true that competition among English railway companies is not at all the fierce rivalry which prevails in this country, especially in the West. Rates in England are stable. They are high, it is true, but this is due to the high capitalization of English railways; and the rate-fixing department of the clearing-house should not be blamed for it.

The great difference in stability of rates in the two countries is shown by the fact that the regular meetings of managers, at which changes in rates are considered, are held quarterly. We have been able in this country, after long agitation, to secure a legal enactment requiring three days' notice of a reduction in rates and ten days' notice of an advance. Such a length of time is of some value, in that it may oblige the class of railway managers who act first and consider afterward to reverse their usual order of procedure. But a child can understand that even a ten days' notice is practically no assurance to a shipper or traveler that rates may not be entirely changed before his contemplated plans are carried out.

In these days, when a single shop, store, or factory may distribute its products over many States, freight rates are one of the most important items entering into a manufacturer's calculations. With no knowledge whether they are to be raised at any time ten days or more in the future, or whether a rival a thousand miles away is to have the advantage of a reduction of rates at any time after three days, his plans for future operations can hardly be very accurate.

The work of the English railway clearing-house has been described in a small pamphlet published in this country by H. V. & H. W. Poor, a reprint of a series of articles published in the *Railway News* of London. Unfortunately the pamphlet is written in a "popular" style, and many points in regard to the working of the system on which American railway managers would like to be informed are left untouched. At the same time much space is taken up with minor matters, which are appropriate enough for a newspaper article, but rather hinder than help one who wishes to gain a clear idea of the actual working of the clearing-house.

However, this book, so far as we are aware at least, is the only one available upon the subject, and now that the work of traffic associations is becoming so prominent a topic, those who are interested in it will find profit in spending an hour or two in reading the important portions of the volume.

There is no doubt that if our numerous railway corporations are to retain their individuality, the traffic associations of this country must conform in some respects to the long-established clearing-house system, and their acts must receive legal recognition and authorization. It seems not unlikely, however, as was noted in these columns last week, that we are to arrive at the solution of the railway problem in this country in a different way; and that in the consolidation of all our railways into a few great systems, each occupying its own territory, will be found a solution of the problem of relative and competitive rates which will be better for both the railways and the public than the complicated clearing house system of the English railways.

CORRESPONDENCE.

Chase's Micrometer Scale.

Office of the Lehigh Valley Railroad Co.
HAZLETON, Pa., Oct. 9, 1889.

TO THE EDITOR OF ENGINEERING NEWS:—

Having had calls for my micrometer scale, I wish to give it to the profession through the columns of your paper.

The Mining Laws of Pennsylvania require maps drawn to a scale of 100 ft. to the inch. A magnifying glass must be used to read feet accurately from such fine graduation. To save that strain on the eyes, I bought a Leslie's micrometer for $23. It soon broke, where second-hand material had been used in its construction, and later it became inaccurate. The extreme range of this micrometer was 150 ft. before the break, and 100 ft. after.

I therefore designed the micrometer scale, of unlimited range, shown above, and had it cut, by Young & Sons, on one side of a 6-in. triangular boxwood scale. The other five sides were graduated as usual, one of them containing the ordinary 100 ft. to the inch scale, for use of those unaccustomed to the micrometer scale. The cost was $1.50.

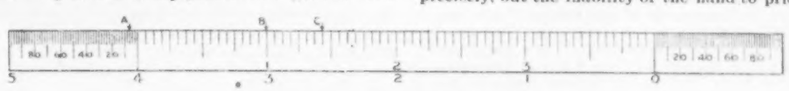
It is two different scales combined. Both end inches are divided into 2 ft. spaces or 50 equal parts; the intermediate inches into 16 equal parts, or 6¼ ft. spaces, thus enabling the nearest quarter of a foot to be read off without the use of a glass.

In use we mentally subtract the distance to be read on the central portion of the scale, leaving only *even* feet to be read on the end inch. For even quarters subtract 6¼, 12½, or 18¾; for odd feet 25; for odd quarters 31¼, 37½, or 43¾.

For example, to lay off 149¾ ft. we use 100 (*A* to *B*) and 43¾ (*B* to *C*), as shown on diagram. Set *A* on starting point, prick off distance at *C*; then slide *B* up to hole made in paper at *C* and test distance by seeing that *A* stands opposite 149¾. If working in the opposite direction, use the other end of the scale in the same manner.

Yours respectfully,
JAMES A. CHASE, C. and M. E.

[Any one who likes this sort of scale will probably find it just the scale he likes, and we therefore give it publicity. There is no accounting for tastes. For our own part, we should infinitely prefer to trust to the "good old way" of reading directly from a well-made scale estimating fractions by eye, and we believe this would prove to be the most accurate as it is by far the most convenient system. It is not only the inability of the eye to estimate precisely, but the inability of the hand to prick off precisely the point where the eye wants it which is to be guarded against; and we are convinced that with ordinary good eyes, more is lost by having to prick off two or more points than is gained by having the gradations just where they are needed, not to speak of the cumbrous calculations necessary for subdividing each measurement into fractions, which opens a wide door for error. Still, every one to his taste.—ED. ENG. NEWS.]



Chase's Micrometer Scale.

Notes and Queries.

W. F. A. writes: In the interesting article which appears in your issue for Nov. 2 respecting "The Trade of the World," the aggregate of exports and imports of the United States for the year 1860 is given as $4,685 millions. This must, of course, be a misprint, and I presume the true amount must have been "468" or "685." Will you kindly inform me which, or what is correct?

It was a misprint. It should have read 685, not 4,684.

O. E. writes: Please give in your "Notes and Queries" height above rail and width of bottom piece of snow-plow, for use in determining size and position of outside guard-rail on bridges.

We give the information in another column.

A. J. Du B. asks for the name of the Japanese inventor of the clever illustration of the cantilever principle, as shown in ENGINEERING NEWS of June 11, 1887. In answer we would state that it was an English and not a Japanese idea at all, and the photograph was taken against one of the sheds in the Forth Bridge erection yard, and Mr. COOPER himself, the well-known assistant of Mr. BAKER in this great work, figures as one of the "towers." The credit for this device undoubtedly belongs to Messrs. BAKER and COOPER, or to some one directly connected with the Forth Bridge. We were somewhat misled in receiving the original photograph; but were corrected by the young Japanese engineer who, while temporarily on the bridge staff, acted as the load on the "suspended span" in the photograph referred to.

Irrigation in Egypt and the Raijan Reservoir.

The following is from a paper by Mr. COPE WHITEHOUSE, read before the Western Society of Engineers, at Chicago, on Oct. 2:

Startling as has been the advance of the western world in rapid transit of persons, merchandise, and thought, the use made of water falling from the mountains to the sea shows no corresponding progress. The engineering works which here and there regulate the flow of a stream in the United States are contemptible in view of what remains to be done, and with scant exception are below the level of even the minor modern constructions to be found among those Oriental nations whom the American engineer has been often taught to despise. It has been an essential feature of that modern philosophy, which is popularly associated with the name of Darwin, that development is an attribute of time. The mechanical engineer, in the presence of such stupendous triumphs as the ocean steamer, or the vast

spans of many a bridge, may fearlessly challenge the past. It is nevertheless true that the unbridled career of our rivers, great and small, exhibits a barbarism so primitive that the founder of the Chinese Empire who restrained the Hoang-Ho; or Menes, who established civilization in Memphis, building the city upon ground laid bare by the diversion of the Nile, would stand aghast at the sharp contrast offered by advancement in the use of steam, steel, and electricity, with the utter neglect of that immense force that represented to the rulers of the East so obviously individual welfare and national empire. Those lords of the Nile would despise us as slaves of the Colorado and the Mississippi, contented to submit with supine tameness to the caprices of our water-courses, as if these rivers were not as amenable to control as the drainage basins of the Abyssinian mountains and the lakes of Central Africa. These questions of irrigation, drainage, and river transportation are hourly assuming greater importance. They have attracted the attention of the American people. They are being carefully studied. The problems will be solved and the difficulties surmounted by that energy and febrile ingenuity which are characteristic of our country. It cannot but prove interesting and instructive to examine irrigation in Egypt, dependent upon that anomalous river which so long ago exercised human thought, and continues to this day to present the same conflict between nature and man.

At the commencement of this century French engineers succeeded, in supreme control, the Pharoahs, the Persians, the Greeks, and the Arabs. Now the ultimate direction is in the hands of about ten British officials trained in India. The native division engineers, however, are men of great local knowledge and practical as well as technical ability. Ali Pasha MUBAREKH, now Minister of Public Instruction, was, when I first made his acquaintance, Minister of Public Works. He is a conspicuous example of success in amassing singularly vast stores of profound and varied knowledge on all subjects connected with the engineering profession.

The current idea of the topography of Egypt is erroneous in the extreme. It is not a sandy plain, traversed by a river whose inundation brings fertility to the farthest parts reached by the life-giving stream. The pyramids are neither in the river as SHAKESPEARE says, nor in the sea of sand, as Dr. BRUSCH describes them. The Nile Valley, to the south of Cairo, is sharply distinguished from the Delta. The Nile itself is practically a double stream. The perennial flow is maintained from the great lakes of equatorial Africa; the inundation is due to the rainfall on the Abyssinian mountains. The supply from the end of February, for about three months, is insufficient for the area under actual cultivation. This is little more than one-half the extent cultivated under the Pharaohs or the Ptolemies. The entire area of cultivated land is artificially irrigated. The inundation of Middle Egypt is everywhere controlled by embankments many thousand miles in extent. In Upper Egypt, as soon as the water rises out of its deep channel, it is allowed to flow into districts of 50,000 to 80,000 acres. Should it afterwards rise higher, it is excluded from these shallow pools, where the fertilizing alluvium is deposited, while the villages with their palm-groves rise above the water like islands, each secured by its own wall of earth strengthened by brick. The high Nile thus becomes a menace. Its flood is forced into a comparatively narrow channel, whose bounds it not infrequently bursts.

In the Delta the inundation is wholly excluded whenever such summer crops as cotton, sugar-cane, and rice are growing. Canals supply enough water for the crops. Scarcely one-twentieth of the whole discharge in flood is utilized.

The missing factor in Egyptian prosperity is the great lake Moeris, described by the ancient historians and depicted upon their maps. The author's discovery of the Raijan Valley, which formed part of this reservoir, offers a means of controlling the flood waters of the Nile, and storing a sufficient portion of its surplus to double the discharge of the river during the annual drought. All the facts have been verified by the Egyptian Government, and reports have been made, based upon the official surveys by Sir C. C. SCOTT-MONCRIEFF, author of the well-known book on Irrigation, Under-Secretary of State for Public Works; Colonel WESTERN, the Director General of Works; Colonel ROSS, Inspector General of Irrigation; Sir EDGAR VINCENT late Financial Adviser to the Khedive; NUBAR PASHA, late President of the Council; Col. ARDAGH, late Chief of Staff in the Army of Occupation, and many others. Lord SALISBURY, Sir J. FERGUSON, and Sir EVELYN BARING have attested the accuracy of these reports, and have conceded the enormous benefits which would accrue to Egypt from the execution of the proposed canal. The Khedive, with his strong love for the people under his care, has always manifested an appreciative sympathy for my investigations.

The Raijan project is briefly a scheme to put the Nile in communication with a depression, 250 sq. miles in area, in the desert to the west of the Nile and about 75 miles south of Cairo. Its circuit of 230 miles is bounded by plateaux of horizontal limestone, after rising to a height of 600 ft. Its soil is desert sand overlying rock and yellow clay. About one-tenth of the area is occupied by steep ridges of blown sand, 60 ft. high. It contains no inhabitants. To the south are two springs, warm and sulphurous, with a few date-palms and a little coarse vegetation. Its greatest depth is 153 ft. below the Mediterranean, or about 250 ft. below high Nile in the adjacent valley. It can be readily utilized to relieve the Nile during flood, assist the drainage of Middle and Lower Egypt, and store water for summer use from April to July.

The shortest and most direct channel through the Berek-Abu-Hamed hill is 6 miles in length. This involves a tunnel or a cutting with a maximum height of 160 ft. A longer, but in many respects easier, route by the Myna Pass is that which has been most fully considered. It has been surveyed with great care and thoroughness. It requires the handling of about 3,500,000 cu. yds. of sand, clay, and soft rock, with an average delivery of the material at 20 ft. above the excavation. The same channel, with a regulator and flood-gates, will be used for both the intake and outflow. The reservoir thus formed would contain about 20,500 million cu. m., or say, 5,000,000 million galls. The average rise of the Nile is about 25 ft. The stratum of water available without pumping would be 250 sq. miles by 25 ft., less evaporation and loss of head. This would yield an average annual supply of about 5,000 million cu. m., or say, 1,250,000 million galls., equal to a daily delivery of 12,000 million galls. during the season of low Nile. The present minimum supply, on which the whole export crop of Egypt depends—its cotton, rice, and sugar-cane—is about 20,000,000 cu. m. per diem, or less than half the amount which could be profitably employed. The Raijan reservoir would more than double the normal flow of the river at this season. The water is now economized in Upper and Middle Egypt as well as in the Delta. The demand for an increased quantity is immediate and pressing. On the completion of the system of Barrage canals, it will require an increase of two-thirds of the present supply to cultivate the land which will be offered for summer cultivation. The total possible increased area of cultivated land has been officially put at 3,000,000 acres. The total volume of Egyptian produce would probably be nearly doubled. Sanitary questions have their economical aspect. The death rate now rises to 92 per 1,000; yet Alexandria was reputed in the Roman days to be the healthiest city on the Mediterranean, while the neighborhood of Cairo and Memphis was famed for its salubrity. The preservation from disaster is a material consideration. The loss by the excessive inundation has reached $5,000,000, while the insufficient Nile last year was officially declared to have cost $1,500,000.

It may therefore be safely stated that a reservoir and canal of escape can be constructed for $2,500,000. It would not require more than one year to make the canal, and probably three inundations would suffice to fill the basin without prejudice to the interests of the present cultivated area. This represents an addition to the wealth of Egypt of not less than $5,000,000 per annum.

Mr. WHITEHOUSE described points of interest on the line of the canal, in the desert, or in that vast adjacent depression—the Fayoum—whose redemption has always been attributed to the Patriarch Joseph, son of Jacob, founder of the temporal prosperity of the Jewish nation and reputed to have been the foremost engineer of ancient days. His dykes, canals, and other works were shown to have remained in continuous operation down to the present day, on a scale of grandeur and with an element of persistence which prove the soundness of judgment as well as the boldness of conception of the engineer who designed and the Government which executed them.

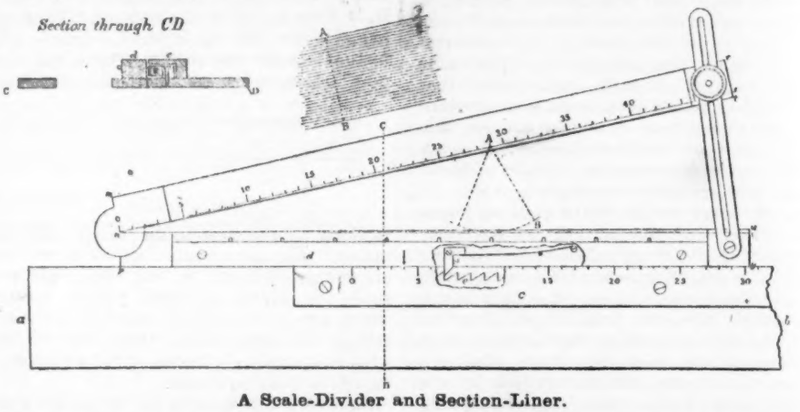
At the conclusion of the paper Mr. WHITEHOUSE was questioned as to the geology of the Nile, and the basin he had discovered, in answer to which he stated that no satisfactory explanation had been afforded of the origin of the basin. He also further explained some of the Physical conditions of the Nile. Being asked as to any financial plan having been devised for carrying out the works, he stated that the money could be obtained without difficulty, but the impediments to immediate work were personal ones, in that an American layman had made the discovery and had pushed the enterprise in the face of a large array of engineering talent and official control.

Mr. WHITEHOUSE explained his theory with regard to the construction of the pyramids. He considered them monoliths cut down from conical hills on the spot and revetted with the rock obtained in the process.

A Scale-Divider and Section-Liner.

The instrument consists of two parts, a straight-edged wooden rule, *a b*, and a second jointed wooden rule (a two-foot rule, for example), *m r y p*. (See Figure.) In the figure only half of the first-mentioned rule is drawn, the omitted half being similar to that shown.

The rule *a b* is provided with a rack *c*, and a



A Scale-Divider and Section-Liner.

ratchet is attached to the jointed rule in such manner that the latter can be shoved one or more spaces of the rack to the right, while but a limited motion is possible to the left.

The metal rack, *c* which can be replaced by a series of equidistant pins if desirable, is covered with a wooden strip *c*, and this, for convenience, is divided into spaces equal to those of the concealed rack.

An index (in the drawing over division 4) enables the number of teeth over which the rule *m r y p* has been slid, to be ascertained with ease.

From the center *n* of the pivot, lines *n s* and *n v*, parallel to the edges *m r* and *p y* respectively, are drawn. In order to render this possible, the widths *r t* and *u y* are made a little greater than *n m* and *n p*. From *n* as a zero point, the line *n s* is divided into spaces equal to those of the rack, *c*.

The slotted arm at the right end of the jointed rule enables the latter to be fastened at any angle to the rack rule.

In order to draw parallel lines, the jointed rule is opened to any angle, and there clamped, while the wooden base rule *a b* is held in place by flat weights of lead. The sliding rule *m r y p* is then moved to the right until the sharp click of the ratchet is heard, and then slid to the left to a firm bearing, and thus held while a line is drawn along the skew edge *m r*. With such continued motion of the sliding rule, parallel lines can be drawn with rapidity and great exactness.

In order to divide any distance *A B* into any number of equal parts, for example into 29, as indicated in the drawing, the distance *A B* is taken in the dividers, one point is set upon the division 29 of the line *n s*, and the rule is then opened until the arc struck from the center *A* is just tangent to the line *n v*; in this position the rule is clamped, and a test made, by sliding the rule over 29 division of the rack, as to the accuracy of the setting. A minute angular change may be needed to secure the highest graphical accuracy, but such accuracy is readily attained.

The draughtsman may for himself divide the slotted bar so as to readily set the instrument at any opening required, in accordance with his immediate need.

This instrument has been in the hands of a number of draughtsmen for over ten years and has proved its efficacy. When used principally for

shading by parallel lines, especially in intricate drawings, a glass straight-edge may be secured to the rule *m n t r* by strips of paper glued to both, and will be found of great service. It is the invention of HORACE ANDREWS, C. E., now City Engineer of Albany, N. Y., and was based upon the principle of MARQUOI's rulers as described in Davies & Peck's Dictionary of Mechanics.

MAKING UP TRAINS IN ENGLAND.—One point of much interest which has been examined by American railroad officers who have visited England this year is the great Edgehill yard of the London & Northwestern, near Liverpool. This is a yard for "sorting and marshaling" freight cars by gravity. It comprises over 57 miles of tracks, and is said to have cost £2,000,000.

This important yard is described by Mr. W. M. ACKWORTH in his recently published book, "The Railways of England." Through this yard all the outward and inward freight traffic of the London & Northwestern passes. About 3,000 cars are handled in 24 hours as a maximum, not as an average, but the yards have a capacity of 5,000 to 6,000 cars per day. Some 54 trains are made up and sent out between the hours of 4 P. M. and 6 A. M. All cars arriving from Liverpool to be sorted and made up are hauled to the summit of an incline and deposited on the reception lines. From these they are dropped by gravity through the sorting sidings and "gridiron" tracks, and come out made up in trains, the cars arranged in the order of the stations at which they are to be left. From 80 to 83 men are employed. No statement is made of the relative economy by which the great expenditure for this yard is justified; but Mr. ACKWORTH states the work done there in 1887 "implied the employment of the whole time of nearly 400 engines, which collectively performed about 2,000,000 hours' work, at a total cost of precisly £497,437."

STANDARD AND NARROW-GAUGE RAILWAYS IN SPAIN.—An interesting railway question has made its appearance in the north of Spain. A narrow-gauge line from Bilbao to Durango has turned out such a profitable enterprise that it is at present paying 12 per cent. interest, and this rate promises to increase still further. Another company has continued the line to Zumarraga, shortening the journey between Bilbao and San Sebastian; but it can still further be shortened by the construction of a line from Bilbao to San Sebastian, the concession of which is demanded as a broad-gauge line, which will run parallel to the Bilbao and Durango, passing exactly the same places. It will, therefore, not only interfere with the through traffic of the narrow-gauge, but also with its local traffic. It will be the first case of true competition of railway traffic in this country, and it is to be feared that the narrow-gauge will be the loser, as the intended broad-gauge line is likely to be in the hands of the Northern system. The importance of the case lies in this: that if a narrow gauge line is made to pay a handsome return, the nearest broad-gauge system will ask for a concession.

THE OHIO, INDIANA & WESTERN Railway Company is to be reorganized under the direction of Drexel, Morgan & Co., if the security holders assent to the plan which that firm has proposed. This plan is to replace the present outstanding securities with an issue of 4 per cent. 50 year first mortgage bonds to the amount of $10,000,000, 4 per cent. non-cumulative income bonds to the amount of $4,000,000, and stock to the amount of $10,000,000. The fixed charges are to be greatly reduced, and a contract has been made with the Cleveland, Cincinnati, Chicago & St. Louis Company by which the payment of these fixed charges is guaranteed by that company. This means, of course, that the lines operated by the Ohio, Indiana & Western Company, which have an extent of 352 miles, are to form part of the Vanderbilt system at an early day. The Ohio, Indiana & Western Company was organized last year and took possession of the bankrupt Indiana, Bloomington & Western Railroad. It is doubtless more familiar to most of our readers under the latter name than under its present one.

THE HAMBURG AMERICAN STEAMSHIP *Columbia* has again beaten the east-bound record from New York to Southampton. Her time on her last trip between Sandy Hook and the Needles was 6, d., 18 h., 10 min.

The Design and Construction of Railway Shops.

(*Continued from p. 416.*)

CAR SHOPS.

The roofed space provided for the repairs of freight cars is usually limited, as 25 per cent. of this work can be done in the open air. The time occupied in the heaviest repair—viz., a rebuild—is short, and the detention of a car in the shop is brief, compared to the delay in the case of a locomotive, so that a total shop surface that will shelter 1½ per cent. of the freight-car stock will be found sufficient. It is probable, if the figures could be obtained, that an average for this continent would show but 1 per cent., and the nearer the approach to uniformity in detail in the car stock, the less the shop room needed.

The total outdoor track space provided for repairs, change of wheels, and shop storage is twice that under cover. There are in this matter wide variations in practice, due to climate and nature of traffic, the cars moving food, clothing, etc., requiring different treatment from cars moving coal and heavy minerals.

Table No. 2 gives from recent practice, the relative area of some American car shops, the percentages being shown in double columns (as explained for Table 1).

TABLE 2.

Showing the relative area of Railway Shop for Car Department. The first column gives the percentages in comparison with the combined area of both passenger and freight erecting shops, which is taken as unity (100); and the second column, the percentage of the total roofed area devoted to car purposes.

Kind of shop.	West Burlington C. B. & Q. Ry.		Como N. P. Ry.		Indianapolis Panhandle Ry.		Chicago C. & N. W. Ry.		Houston H. & T. C. Ry.		Waterville Me. Cen. R'y	
	Per ct. of erecting shops.	Per ct. of whole.	Per ct. of erecting shops.	Per ct. of whole.	Per ct. of erecting shops.	Per ct. of whole.	Per ct. of erecting shops.	Per ct. of whole.	Per ct. of erecting shops.	Per ct. of whole.	Per ct. of erecting shops.	Per ct. of whole.
Pas'ger Coach erecting	100	20	100	21	100	17	100	24	100	30	100	22
Freight Car erecting		20		16		17		12		23		18
Paint per both	56	24	77½	30	77	26	68	25	45½	24⅛	†100	39
Machine (iron)	Locom used.	shops	29	11	19	6½	22	8	23	12½	Locom used.	shops
Machine (wood and saw mill)	38	16	27	10	38	13	*34	*12½			41	16
Stores	42	17	17	7			31	11	4	2	13	5
Offices									3½	2		
Engine and boiler house	5	2	10	4	5	2			2	1		
Dry Kiln			4	1			5	1¾				
Upholste'y and Varnish					32	10						
Cabinet					29	8½						
Smithy							12	4½	9	5		
Tin shop, etc							2	1				

* Includes Cabinet shop.

† Includes Locomotive paint shop.

The annular form of car shop with radial tracks is occasionally used in America, requiring a turntable of exceptional dimensions, usually 100 ft. in diameter, to permit not only a coach or two freight cars, but also the small tank locomotive doing the shunting, to turn upon it. A large amount of shunting is required in and about a freight car repair shop, due to the short time occupied in an average repair to a car, and the passage of each vehicle over a turntable adds both to the time and to the cost of shunting.

The supposed difficulty in utilizing the whole floor space of a longitudinal shop, and which the annular shop was designed to avoid, is the delay in taking out a string of cars until all are finished, thus sometimes keeping the workmen idle waiting for work. However, even in one of the best examples of the annular shop, that of the Pennsylvania Railway at Altoona, the radial tracks were intended to be three cars long, and therefore some sorting and dividing of cars is necessary before they can be put in, and all that the other type, with its long tracks, requires is that this classing together of cars be done with a little more care and judgment, so that the whole string will be finished and ready to shunt out at the same time. There are good points in favor of the annular shop, if it is intended exclusively for new construction, one being the ease and rapidity with which material on trolleys is delivered close to the workmen.

However, the author would endorse the longitudinal freight car shop, which is of the simplest construction, often wide enough for six or seven parallel tracks, and from 200 to 500 ft. long. The walls, of brick or wood, the roof almost flat (the slope each way from middle being about one in twelve) and supported by timber posts 8 or 9 ins. sq. The posts, though numerous, do not seriously interfere with the work. The roof covering is cut for numerous skylights, gable-shaped, and of quick pitch. Usually the floor is flush, that is, neither track pits, cranes, nor hoists are provided. The car bodies to be lifted being light and bulky, and requiring in many cases to be sustained after they are lifted, it is found best to use quick-moving hand jacks to lift, and dogs or trestles to effectively support them, while the men do the work of repairing.

Numerous trolly roads cross the building in both directions, their union at intersection being made by cast-iron turntables revolving on a central spindle. These tables may be of two castings, a base, forming both pit and foundation, and a revolving top with socket on under side.

This building and its contents are so liable to destruction by fire as to justify large water pipes and numerous fire-hose hydrants within it as well as without.

There is no real economy in the endeavor to repair freight cars and passenger coaches under one roof. The work is so different in character that men can rarely be transferred from one class to the other, and the dirt and dust inseparable from the cars should be kept away from the coaches. When both classes of repairs are done in the same building, it is imperative that a shop free from dust and at a higher temperature be used for painting and varnishing coaches in. It is often built directly opposite to the car repair shop, with a transfer table between. Here, as elsewhere, entrance from both ends of a longitudinal shop is desirable, and has been obtained in many recent designs.

At the Como workshops on the Union Pacific Railway, each stall in the paint shop is provided with an electric call bell, communicating through signal code both with the foreman's office and the paint store, which latter building, as in all railway shops, is detached, and as far as possible of fireproof construction. Often it is provided with an underground cellar for the storage of all inflammable fluid. According to the best practice, only one man at a time is allowed to work in this house mixing the paints and blending the colors, and in some cases the brushes and other tools used by the workmen are stored here and only issued as required. It is a "paint tool-room" in which much the same system prevails as in the "machine tool-room."

WARMING AND VENTILATION.

Paint shops need special facilities for warming and ventilation. A successful arrangement is the use of a fan to draw air through a nest of small steam pipes, and then to force the warmed air into a light galvanized iron tube, from which it is passed into overhead branch pipes and delivered through slide-gratings below, the slides being within the control of the workmen.

At Columbus the paint shop is 75 by 135 ft., containing 272,065 cu. ft., and the steam pipes have a surface of 1,094 ft., or one superficial ft. per 263 cu. ft. The fan has a maximum delivery of 218 cu. ft., and has been run as high as 200 revolutions per minute. The three main pipes leading from it are

30 and 24 in. diameter; and the smallest delivery pipe is 8 in. diameter. The air is used over and over again, and so used, it is said, without any annoyance from the odor of the paint. Running the fan during working hours only reduces the time in which the paint dries by one-tenth. The apparatus is widely adjustable to suit the varying temperatures, as either live or exhaust steam can be turned into the heater pipes, and its amount regulated; or the speed of the fan can be varied within large limits, to which end a separate engine 6 in. by 9 in. stroke, with steam at 80 lbs. pressure is used to give it motion. The success that attended this experiment has justified Mr. E. B. WALL in extending this system at Columbus to the machine, boiler, and blacksmith shops and the annular car repair shop. At Bloomington the new locomotive erecting shop is warmed in this manner. The exhaust steam from the stationary engine is passed into an old boiler, through the tubes of which the air is drawn, and then delivered into underground pipes, the outlet gratings being at the floor level.

This hot air method was in 1886 adopted for widely scattered shops at Cleveland, O., by Mr. J. WALKER (see his communication to the Civil Engineers' Club of Cleveland, Sept. 13, 1887). He used a fan 10 ft. outside diameter with engine 6 in. by 9 in., running from 50 to 275 revolutions per minute, the fan outlet being 42 in. sq. With underground conduits across the yards, he finds that it requires 1 superficial foot of steam pipe for each 100 cu. ft. of shop space, the initial air temperature when entering the fan varying from 100° to 180° Fahr. The conduits are of sewer pipe, the largest diameter of any main being 24 in., and they are trapped so as to get rid of any water that might gather. After the ground had dried, there was no appreciable loss by radiation from the buried mains. This arrangement permits the fan and heater to be kept within the boiler house, and the water of condensation to be returned to the boiler at a temperature averaging 180°; but the air is not used a second time, which explains the increased ratio of pipe heating surface per cubic foot of space to be warmed. However, the shops and foundry are kept clear of smoke, the health of the men is all that can be desired, and the system can as readily be adapted to cooling in summer as to warming in winter.

Illustrative longitudinal types of coach and car shops may be seen at the Grand Trunk Railway Works, Point St. Charles, and one of the worst specimens of the circular shop, although a very showy building, at Mount Clare on the Baltimore & Ohio Railway. It is 235 ft. inside diameter and fully 114 ft. to top of dome, yet has only space for 21 coach stalls and an inlet track.

(TO BE CONTINUED.)

AN ESSENTIAL IN BLUE PRINTS.—A recent writer calls attention to what he pronounces the prime requisite for making positively good blue prints, namely, a good tracing. The best material for this purpose is tracing cloth; but if tracing paper be used it should have a bluish, never a yellowish, tint; neither should the paper be too thick, as in this case light will slant through the tracing under the lines; the tracing should have no creases or wrinkles, and it is imperative that all lines of the tracing, down to the very finest, be absolutely black. Again, when ink does not give sufficiently opaque lines, it can be improved by adding burnt sienna, burnt umber, or gamboge—this, though detracting from its quality as a black drawing ink, makes it better for tracings to be printed. Again, the proper exposure of prints renders necessary a print frame, with strong springs; and an even, thick, elastic cushion; and to wash them it is essential to have water in a vessel or bath tray, as large as the tracing, the bath to be slightly tepid, or at least not cold. In printing, after removing the back of the frame and the cushion, the tracing is to be placed on the glass, with the ink side against it, placing on that the prepared paper, the prepared side toward the tracing, smoothness being essential, after which the felt cushion is put on uniformly, and the frame closed and locked.—*Exchange.*

THE EIFFEL TOWER ELEVATORS carry 60 persons at once, and are nearly always crowded. The fare is 2 francs to the first platform, 1 franc thence to the second, and 2 francs thence to the top, or 5 francs in all.

A Manual of Railway Field Work and Laying Out of Works.[1]

ACCORDING TO THE MOST RECENT AND APPROVED PRACTICE ON AMERICAN RAILWAYS.

BY A. M. WELLINGTON,
M.Am.Soc.C.E., M.Inst.C.E., etc.

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[*Continued from* p. 427.]

[The author will be pleased to receive typographical or other corrections, or suggestions as to form or substance, from any interested reader. All such suggestions will have full consideration.]

All the calculations required in railway field-work can be made by the aid of tables giving the ordinary trigonometric functions as above described, but a large proportion of the calculations required for the special work of laying out curves are greatly facilitated by the use of some different kinds of angular functions, computed not for a radius 1 but for a radius 5730[1] (5729.65), which, as we shall shortly see, is the unit radius for railway curves, or the radius of a 1° curve.

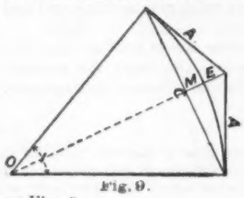

Fig. 9.

These functions are termed the FUNCTIONS OF A 1° CURVE, and are those indicated by the lettered lines in the accompanying Fig. 9, viz.:

Apex-Distance *A-D* (also called the Tangent), marked *A* on Fig. 9.

Long Chord *L-C*, marked *C* on Fig 9.

Middle Ordinate *M O*, marked *M* on Fig. 9.

External Secant *E-S* (also called simply the External), marked *E* on Fig 9.

Length, *L*, of curve.

To these may be added another function of occasional use for facilitating field-work (see § ——) but not directly needed in computing the elements of curves, viz:

The Difference, *D*, between the length of the curve *L* and the length of the two Apex-Distances *AA*, [or *2A—L*], from tangent point to tangent point of curve.

All these functions [except *L*, which (§——) is expressed at once by the degrees and decimals of the central angle] are computed for a radius 5730[1] and for each minute or ten minutes of arc, and used with great economy of labor, in place of the ordinary angular functions, in many computations relating to curves, the advantage being analogous to that which results from having tables of all the angular functions instead of a table of sines only, although all the rest might be deduced as required from a table of sines. The number of necessary steps in computations is much lessened.

Versed sines and external secants are angular functions even more frequently useful in railway field-work than the usual sines, cosines, tangents, and co-tangents, when angular functions only are used, and accordingly some of the more recent field-books contain full tables of these functions, both natural and logarithmic. But when the circular functions are similarly tabulated, they are so much more useful than even the versed sines and external secants that the latter become superflous. A brief table of these natural functions is given, however (Table 27), as of possible occasional use.

The functions of a 1° curve will hereafter be symbolized thus in formulae:

$$A\text{-}D_1,\ L\text{-}C_1,\ M\text{-}O_1,\ E\text{-}S_1,\ L_1,$$

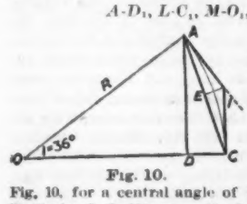

Fig. 10.

For example $A\text{-}D_1$ 36° means the Apex-Distance for a 1° curve of a central angle 36°, or the length of the line $A\,I = I\,C$, Fig. 10, for a radius $R = 5{,}730$; just as sin 36° means the length of the line $A\,D$, Fig. 10, for a central angle of 36° and radius $R = 1.00$. Similarly, $L\text{-}C_1$ 36° means the length of the line AC for $R = 5{,}730$, as cos 36° means the length of the line $O\,D$ for $R = 1$, and $(MO_1 + E\text{-}S_1)\,I$ means the length of the line $E\,I$, Fig. 10, for $R = 5{,}730$, and given central angle I, just as $(\sin + \cos)\,I$ means the total distance $O\,D + D\,A$ for $R = 1$.

The subscript, in these symbols, to indicate that the values for the unit radius of 1° curve are intended, is not really essential, any more than it is essential to write sin 10°, to indicate that a sine for a radius 1.00, and not for some other radius, is intended. But the subscript, is used as an assistance to the mind, in view of the fact that these circular functions are less familiar than the ordinary trigonometric functions, although in nature and use they are precisely analogous.[1]

Circular curves may be designated either by their Radius *R*, or their Degree *D*. In American practice, and increasingly throughout the world, railway curves are designated by their Degree.

THE DEGREE OF A CURVE is in its original conception, and to a great extent in practical work, the angular change of direction in a distance along the arc equal to the unit of measurement, 100 ft., or to the central angle subtended by a length of arc of 100 ft. A ONE DEGREE curve, by this definition, will be 360° × 100 = 36,000 ft. in circumference and its radius will be:

$$\frac{36{,}000}{2\pi} = 5729.58$$

log 36,000		4.55630
" 2	0.30103	
" π	0.49715	
" 5729.58		3.75812

(Exactly, when computed by 7-place logarithms, 5729.578.)

Under this definition, a 2° curve, or one which changes its direction 2° in 100 ft. of arc, will be of precisely half the circumference, and since the radius is directly as the circumference, of precisely half the radius, or $\frac{5729.58}{2}$. Similarly, the radius of a 3° or 4° curve will be precisely ⅓ or ¼ the radius of a 1° curve, and generally, the radius of any *D*° curve will be inversely as the degree of curvature, or $\frac{5729.58}{D}$.

In practice this exact coincidence is not secured nor is the degree of curve based upon the length of arc, but upon the angle subtended by a chord of 100 ft., and hence the proper definition of a 1° curve is one which a chord of 100 ft. subtends a central angle of 1°. As a chord is always shorter than the intercepted arc, and as the disproportion increases with the size of the arc subtended by the chord, curves of different degrees when laid off by chords of equal length no longer have radii which are precisely in inverse ratio to the degree of curvature.

For short arcs of 6° to 8°, however, the length of the chord and the subtended arc are so nearly identical that in practice the radii and degree of curve are maintained in substantially exact inverse ratio to each by the simple expedient of running in the sharper curves with shorter chords, as will be shortly described.

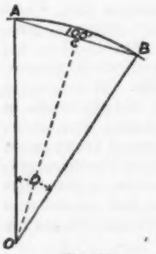

Fig. 11.

TO DETERMINE THE RADIUS R FROM THE DEGREE OF CURVE D, under the correct definition for degree of curve given above, and for a unit chord *c* of 100 ft.

In Fig. 11 draw the line *Oc* perpendicular to the unit chord *c*. Then we have:

$$R \sin \tfrac{1}{2} D = \tfrac{1}{2} c$$

and substituting its value (100) for *c*, we have:

$$R = \frac{50}{\sin \frac{1}{2} D} \qquad (1)$$

For the radius of 1° curve we have:

log 50	1.69897
sin ½ *D*	7.94084
	3.75813

$R = 5729.65$

By the assumption of §——, that the degree of the curve is determined by the angle subtended by an arc of 100 ft. we had $R = 5729.58$

Difference of radius 0000.07

The difference of circumference will be $0.07 \times \pi$ or 0.22, and the difference per 100 ft. of circumference will be $\frac{0.22}{3600} = 0.00061$; that is, the ratio of arc and chord is

Chord	1.0000000
Arc	1.0000061

showing that the two are practically identical. Consequently, the curve is not sensibly affected

[1] The value 5730 is used for these computations in preference to the exact value of the radius of a 1° curve, 5729.65, for reasons to be explained in § ——.

[1] Most recent field-books have contained tables of these circular functions, since their utility is so great as to have been long obvious; but this is the first field-book in which they have been placed in their true logical status as a special kind of angular functions more suited for this particular work than the usual trigonometric functions, and it is also the first field-book in which logarithmic 1° curve functions have been included, so that they can be readily used in all the usual logarithmic computations. *It is particularly necessary, therefore, that the above paragraphs in regard to them should be thoroughly understood and remembered.*

whether it be run with long chords of 100 ft. or by a series of short chords of any length less than 100 ft.

Computing the radii for a number of other curves of different radii, assuming all to be run in by 100-ft. chords, we have the following:

	$D=1°$	2°	5°	10°	20°
log 50	1.69897	1.69897	1.69897	1.69897	1.69897
sin ½ D	7.94083	8.24186	8.63968	8.94030	9.23967
log R	3.75813	3.45711	3.05929	2.75867	2.45930
R =	5729.65	2864.93	1146.28	573.69	287.94

By the assumption of $\frac{s}{100}$, that distances are measured along the arc, we should obtain for the same radii, all being in exactly inverse ratio to D:

R =	5729.58	2864.79	1145.92	572.96	286.48
Differences	0000.07	0000.14	0000.36	000.73	001.46

It will be seen that the difference of radius resulting from considering the degree of the curve to be the angle subtended by a chord of 100 ft. instead of an arc of 100 ft. is insignificant for either a 1° or 2° curve, and of small importance even for a 5° curve, being less than half a foot, but at 10° it becomes more serious, and at 20° inadmissibly great.

If other than 1° curves were defined by chords varying in length directly as the radius R, or inversely as the degree of curvature D, so as to subtend equal central angles, then would R and D continue in precisely inverse ratio to each other on all curves.

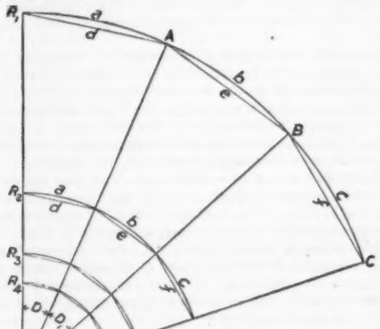

Fig. 12.

For in Fig. 12 let R_1, R_2, R_3, R_4, be a series of arcs, having the radii in any ratio to each other. Draw the radii $O\,R_1$, $O\,A$, $O\,B$, $O\,C$, etc., and subtend the arcs $a\ b\ c$ thus cut off by chords $d\ e\ f$. Then will all the sectors thus formed be proportional to each other, and all the chords proportional to the radius.

Consequently by using 100-ft. chords for 1° curves only, $\frac{100}{2} = 50$ ft. chords for 2° curves, $\frac{100}{4} = 25$ ft. chords for 4° curves, and $\frac{100}{D}$ chords for $D°$ curves, the radius will still be inversely as the degree of curvature in curves laid out by chords, as in curves laid out by length of arc.

In practice, to vary the length of chord with every degree of curvature is inadmissible. On the other hand, as curves grow sharper, it is more important, and it is customary in practice, to fix by stakes a greater number of points on the ground, and in order to do this conveniently and secure likewise the great advantage of a practically constant ratio between the degree and radius of a curve, the following practical rules have been established:

Curves of 1° to 8° are run in with chords of 100 ft.
" 8° to 16° " " " " 50 ft.
" 16° to 32° " " " " 25 ft.
" 32° or more " " " " 10 ft.

or with shorter chords in any case if desired, and as convenient.

Under this convention the precise formulæ for the radius of practice (Equation 1) become:

Curves of 1° to 8° $\quad R = \frac{50}{\sin \frac{1}{2} D}$ ..... (2)

" 8° to 16° $\quad R = \frac{25}{\sin \frac{1}{4} D}$ ..... (3)

" 16° to 32° $\quad R = \frac{12.5}{\sin \frac{1}{8} D}$ ..... (4)

" 32° or more $\quad R = \frac{5}{\sin \frac{1}{20} D}$ ..... (5)

Many engineers make a practice of running in all curves of over 3° to 5° with 50-ft. chords; all curves sharper than 6° to 10° with 25-ft. chords, etc.; and the practice is a good one, for the reason that it is highly convenient to have sharp curves defined by frequent points, to guide the grading more accurately and permit the loss of points in construction without inconvenience.

By Equations (2) to (5) the radii in Table 31 are calculated. The radius being but little used in practical field-work except for plotting or for computing quantities much smaller than itself, every real requirement is fulfilled by a radius exact to the nearest foot, and within this degree of accuracy (that is, with less than 0.5 ft. of error) the radius of any curve whatever is given by the general formula

$$R = \frac{5730}{D} \quad \ldots\ldots \quad (6)$$

or the degree of the curve, given the radius, by

$$D = \frac{5730}{R} \quad \ldots\ldots \quad (7)$$

This formula should be memorized. The effect of using in it the even figure 5,730 in place of the exact 5729.65 as the unit radius, for a 1° curve, is to decrease the error resulting from use of the formula for computing radii of other sharper curves, since these radii are somewhat longer than in exact ratio. Thus for a 5° curve, the exact radius, as given above, is 1146.28 ft. By approximate equation (6) we obtain $\frac{5730}{5} = 1146.0$ ft. Were 5729.65 used in place of 5730 in Equation (6) we should obtain 1145.93,—an error of 0.35 instead of 0.28 ft.

No defect of earlier field practice was more unfortunate than basing it upon the wholly unnecessary assumption that all curves, however sharp, are to be run in with 100-ft. chords. The effect of it was to destroy exactness of ratio between the radius R and degree D, and even, on very sharp curves, to make corrections necessary in the length of sub-chords ($\frac{s}{100}$), thus greatly and unnecessarily complicating many of the formulæ, as notably in preventing the systematic use of the "functions of a 1° curve," to be shortly determined, in place of the usual trigonometric formulæ. It had likewise the bad effect of encouraging the running in of sharp curves with too few points. The contrary practice has been long established among the best field engineers, but this is the first field-book in which it has been formally recognized and embodied in the tables and formulæ, with an effect to simplify them which will become very evident by comparison.

Under the natural method even the sharpest curves become strictly symmetrical. Thus, a curve of 114.6 ft. radius is a $\frac{5,730}{114.6} = 50°$ curve, and by $\frac{s}{100}$ is run in by 10-ft. chords. Its exact radius, so run in, by Equation (5) and Table 31, 114.59 ft. Under the mistaken system of the older field-books, even such a curve is supposed to be run in by 100-ft. chords if run at all, and it then becomes a 51° 45' curve, and intermediate pluses cannot be filled in without separate computations of the proper length of each sub chord.

A correspondent makes the following criticisms:

First.—I think we number stations from "0 on," not from "1 on," otherwise it would take 53 + 80 to make a mile, for we certainly put in a plug and station at the beginning and I think call it "station 0," possibly incorrectly, but it is certainly common practice, or used to be. However this is a small matter.

Secondly.—I do not think you should teach the young idea to throw away the original location when running track centers, especially of straight lines, rather teach it to preserve it by reference plugs and otherwise.

Curves do not make such a difference; they may be compounded every hundred feet without being noticed. How I wish I had learned this earlier! But straight lines I think should be preserved at all hazards.

1. The plug from which the survey starts is certainly numbered 0, but the first *station* stake set is numbered Station 1. A word may judiciously be added, however, to make the meaning clearer, and will be.

2. It is well to teach the "young idea" precisely the truth, and the truth is that it is often expedient for several reasons to run an entirely new center line to fit the graded track, regardless of the old notes, and rarely or never possible to follow the old notes exactly. It is, of course, none the less necessary to carefully reference the transit points of the location before construction begins.

Mr. A. E. BACHERT points out a slip of the pen by which it was stated that "A witness stake or guard stake is set about a foot to the right of the plug, with the marked side toward it," when it should have read to the left of the plug. He justly continues: "By setting them to the right the figures must either be read inverted or read when looking toward the beginning of the line, which, in the latter case, necessitates walking by the stake and facing about, unless, peradventure, he would have stakes marked so as to have numbers reading from bottom to top, which, I think, is not the way they are generally marked." The latter is not the general nor proper practice. The marking begins at the top of the stake.

Mr. E. P. DICKEY writes in regard to arrangement of tables: There should be a better way of arranging the tables than is adopted in most field-books. In text-books at school the table of logs of numbers comes first, then follows log sines and co-sines, then natural sines and co-sines, etc. Why not continue this method? The engineer learned it while it while young and the thing is hard to unlearn as he gets older. Have any additional tables arranged according to their bulk, so the shortest will be the last in the book. A person would then know just about where to look for the table he wanted. Again, why not have one or two of the tables most frequently referred to, for instance the functions of a one degree curve, on tinted paper. This would divide up the tables into groups so after a little practice a person could easily find desired tables without regard to index or having to fumble over all the leaves in the book.

The arrangement which has been adopted is to put the tables in an alphabetical order, which proves to come sufficiently close to a natural or logical order to make it convenient. As this question is a very important one, however, and as the tables, once set, cannot well be changed in arrangement, a list of the tables and some notes as to their proposed order and arrangement on the page will be published shortly before setting of tables begins.

The same correspondent suggests that a field-book should be bound in two thin volumes, text and tables separately, instead of in one thicker volume. This idea is not new. It seems to have much to commend it and has been already tried, but it has not seemed to commend itself to popular favor, the trouble being that the part wanted is not at hand in the emergencies when it is most needed, and which cannot be exactly foreseen.

Mr. A. A. SCHENCK writes: I suggest that in Part VI. a full explanation be given of just what the middle area is which is required in the prismoidal formula, and also how it is to be obtained, especially when the end areas are irregular. In all the works I have seen recommending the use of the prismoidal formula, the above explanations have been passed over almost in silence, leaving the advice to use that formula practically a dead letter to young engineers. I would also suggest a statement whether the use of the "end area" method of calculation is allowed by statute in any States, as has been stated; and whether custom could compel its use, in case of dispute.

The exposition of the theory and practice of the application of the prismoidal formula to earthwork computation, and when it is useful and when useless to do so, will be made very full, and it is hoped, clearer and more in consonance with the best practice than in many older works. As to the state of the law on this subject we can only say that to the best of our information and belief there are several States which distinctly authorize by law the "end area" method; but we question if the law would be held to be constitutional, for reasons we have briefly outlined editorially. That custom could compel its use in case of dispute, if it were shown that more accurate methods of computation had been used, we do not believe; but that a computation made solely by "end areas" could be defended in the courts as sufficient, unless it were shown to have been applied to numerous solids where its use involved great error, we regard as equally certain.

THE COLORADO CAÑON SURVEY will be recommenced in a few days by Mr. ROBERT B. STANTON, Chief Engineer of the Denver, Colorado Cañon & Pacific Railway, who will take up his survey where it was dropped in consequence of the death of President FRANK M. BROWN, in the heart of the Marble Cañon, and complete it through the Marble and Grand Cañons.

RUSTLESS IRON.—The rustless process, which has been until lately an experiment, has now demonstrated that economy can be exercised, not only in ice pipes, but in every article where iron is used. In the past year over 2,000,000 kettles have been subjected to this process in Pittsburg. The method is very peculiar. After the article is made it is put into a furnace about 3½ ft. high, 15 ft. long, and 8 ft. broad. The furnace is made in an oval shape, air tight. After the iron has been in the furnace for two hours, and has attained almost a white heat, the air that comes through the regenerators and air valves is shut securely off, and the furnace is made air tight.

After the air has been shut off, the super-heater, which is located in the combustion chamber at the rear of the furnace, and at right angles from the air valves, is opened, and the furnace is filled with steam and kept in this condition for eight hours. At short intervals a small valve is opened, so as to allow an exodus of steam in the furnace, allowing fresh steam to be put into the furnace.

When the articles have been ten hours in the furnace there has been accomplished the formation of magnetic oxide upon the iron surface. They are then put into an acid well, which is the last treatment.—*Pittsburg Dispatch.*

THE STATISTICS OF THE WORLD'S TELEGRAPH AND TELEPHONE LINES.—The total length of the telegraph lines of the world amounts to 557,064 miles, —Europe, 216,490; America, 165,642; Asia, 46,800;

Australia, 24,204, and Africa, 12,060 miles. There have to be added 950 submarine cables, 774 of which are laid in European seas, and have a total length of 3,300 miles, while the remaining 176, with a length of cable of 85,850 miles, belong to companies. The service of these lines is carried out by 160,000 offices. Telephonic statistics are as follows:

The United States, 739 exchanges and 158,712 subscribers; Germany, 164 exchanges and 31,325 subscribers; England, 122 exchanges and 20,420 subscribers; Sweden, 137 exchanges and 12,864 subscribers; France, 28 exchanges and 9,847 subscribers; Switzerland, 71 exchanges and 7,626 subscribers; Russia, 36 exchanges and 7,589 subscribers; Italy, 28 exchanges and 6,183 subscribers; Belgium, 4,674 subscribers; Austro-Hungary, 4,200 subscribers; Norway, 21 exchanges and 3,930 subscribers; Holland, 9 exchanges and 2,872 subscribers; Spain, 2,218 subscribers; Denmark, 1,837 subscribers; Portugal, 2 exchanges and 890 subscribers. The town with the largest number of subscribers is Berlin, which has upward of 10,000, and is followed by New York, 6,900; Paris, with over 5,000; and London about that amount.—*Exchange.*

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Kennebec Central.—The contract prices for building this road are as follows: 24 cts. per cu. yd. for earthwork, 60 cts. per cu. yd., for loose rock, $1.50 per cu. yd., in solid rock, $40 per acre, for clearing and grubbing, $3.50 per cu. yd., for culvert masonry, $1.75 per cu. yd., for paving, 75 cts. per cu. yd., for rip rap. Michael O'Neil, of Cumberland Mills, Me., has the contract. The road is to run from Augusta to Togus, Me. FREDERIC DANFORTH, of Gardiner, Me., is Chief Engineer, and H. H. TRIPP is Assistant Engineer.

Toledo, Columbus & Cincinnati.—Tracklaying on this road from Findlay, O., south is progressing at the rate of one mile per day. It is expected to have the line completed to Kenton, O., within a month.

Michigan Central.—It is stated that the Belt Line around Bay City, Mich., will be completed in about 30 days. The line is 3½ miles long and runs south from Water St, around the city to the Bay City division of the Michigan Central R. R. At first the line will be used only for freight, but later passenger stations will be established. In addition to this work a storage and assorting yard is being established which covers 67 acres. This yard will have a storage capacity for 3,000 cars and the assorting yard will hold 300 more. The new yard is very nicely laid out and will facilitate the handling of Saginaw Valley traffic very materially. It is situated near the junction of the Belt Line with the Bay City division.

Central R. R. of New Jersey.—The Orange County R. R., running from Burnside to Greycourt, N. Y., is nearly completed. The line is 10¼ miles long and will form a connecting link between the Central R. R. of New Jersey and its allied lines and the Philadelphia & Reading, and the Lehigh Coal & Navigation Co. railways.

Philadelphia & Reading.—The Allentown Terminal R. R. Co. has issued $450,000 of bonds guaranteed by the Philadelphia & Reading and the Lehigh Coal & Navigation companies. The proceeds will be used in building the line which is to furnish terminal facilities for the Philadelphia & Reading and the Lehigh Valley railways. The line will be about 3 miles long.

Cleveland, Cincinnati, Chicago & St. Louis.—It is announced that construction will soon begin on the Louisville, Cincinnati & Dayton R. R., which is projected to run from Aurora, Ind., to Louisville, Ky., a distance of 100 miles.—The surveys have been completed for the line from Springfield to Columbus, O., a distance of 42 miles. A very favorable route is reported to have been secured.

Central Vermont.—The annual report of this company for the year ending June 30, 1889, shows the following results from operations.

Gross earnings	$4,780,912
Operating expenses	3,358,734
Net earnings	$1,422,178

Baltimore & Potomac.—This company has executed a consolidated and blanket mortgage for $10,000,000 to the Safe Deposit & Trust Co., of Baltimore, Md. The money is to be used in retiring outstanding bonds as they become due and in making repairs and additions to the roadbed and equipment.

Washington & Potomac.—It is announced that a corps of engineers are at work on the extension of this road from Mechanicsville to Point Lookout, Md., a distance of 45 miles. The present company is the successor of the Southern Maryland R. R Co., which was chartered in 1868 to build a railway from Washington, D. C., to Point Lookout, Md., a distance of 80 miles. The road was completed from Brandywine to Mechanicsville, Md., 30 miles, shortly afterwards. In 1884 a short line 2.3 miles in length was built in the District of Columbia. Since then nothing has been done on the line. It is now announced that the property has come into new hands, and that the road will be completed as projected.

Western Maryland.—The surveys for the proposed line from Williamsport, Md., to a connection with the Baltimore & Ohio R. R. at Cherry Run, have been completed. It is stated that the route has been approved, and that construction will soon commence.

Baltimore & Ohio.—It is stated that the $80,000 of bonds issued to build the branch from Boyd's Station to Seneca, Md., have been taken, and the right-of-way for the line secured. The Seneca & Potomac R. R. Co. was incorporated some time ago to build the road.—The company will soon begin the construction of a line from Suterville to Jeannette, Pa., 15 miles.

Temiscouata.—A correspondent informs us that work has just been commenced on the St. Francis branch of this road. The road leaves the main line at Edmundston and runs up the St. Johns River. It is not intended to do much work this season, but next season about 20 miles will be built. Malcolm & Ross have the contract.

Projects and Surveys.

Wheeling, Wellsburg & State Line.—Steps will soon be taken to consolidate this company with the Pittsburg, Cannonsburg & State Line R. R. Co. The object of the consolidated company is to build a railway from Wheeling, W. Va., to Pittsburg, Pa., a distance of about 65 miles. The officers and directors of the new company are: CHARLES MAYRAN, President, JOHN B. DONALDSON, WM. H. PAXTON, S. MUNNEL, and JOHN F. BUDKE, of Cannonsburg, Pa., and A. E. SUCCOP, E. H. MYERS, JOS. ABEL, H. S. DUNCAN, H. H. NIEMANN, and B. L. WOOD, Jr., of Pittsburg.

Grand Rapids & Lake Michigan.—This company, whose incorporation was noted in our issue of last week, has completed the survey for its proposed road from Grand Rapids to Holland, Mich. The officers of the company are: W. D. TALFORD, President, GEO. P. HUMMER, Vice-President, JOHN C. POST, Secretary, F. A. HALL, Treasurer, and C. E. TEMPLE, Counsel.

South Sudbury & Worcester.—A dispatch states that surveys are in progress for this road, which is projected to run from South Sudbury to a connection with the Central Massachusetts R. R. at Mariboro, Mass.

Beach Creek, Pittsburg & New York.—This company has been granted a charter to build a railway connecting the Beach Creek R. R. with the Pittsburg & Western R. R.

Canada.—It is announced that a company has been formed to build a bridge across the St. Lawrence River at Quebec and a railway to the Straits of Belle Isle. The Dominion Parliment will be asked to grant a subsidy in aid of the enterprise.

Edmundston & Moncton.—A correspondent informs us that surveys are in progress for a line of railway to run from Edmundston to Moncton, N. B. Three parties are in the field working under direction of R. A. DAVY, of Rivière du Loup, P. Q. The surveys will be completed by December.

Vincennes & New Albany.—It is stated that surveys are in progress for this road from Vincennes to New Albany, Ind., 125 miles. A syndicate is said to have been, formed to build the road. Construction is to commence early next spring.

Kimbolton & Mansfield.—A project is on foot to build a line of railway from Kimbolton to Coshocton, O. and thence up the Walhonding and Mohican Valley to Mansfield, O. A. J. WARREN, of Coshocton, is interested.

SOUTHERN.—Existing Roads.

Georgia, Southern & Florida.—W. H. WELLS, of Macon, Ga., Chief Engineer, has sent us the following information concerning the Macon & Birmingham R. R.:

The road is to run from Macon, Ga., via Thomaston, Greenville, La Grange, Talladega, and Leeds, to Birmingham, Ala., a distance of 130 miles. The work is generally heavy; maximum grade 1 per cent, and maximum curve 5°. There will be bridges across the Flint, Chattahoochee, Tallapoosa, Coosa and Cahaba rivers, and one tunnel. The route is through a fine agricultural country for about 100 miles and the remaining 70 miles is through a rich mineral country. It is expected that the road will do a large business in lumber, minerals, and agricultural produce and will obtain a large through traffic from the West and Northwest to the Gulf coast. The preliminary surveys have been completed and about 80 miles of the line from Macon west located. J. S. McTighe & Co., of Memphis, Tenn., have the contract for building the road and will commence work Nov. 15. The first 80 miles are to be completed by May 15, 1890. The work is in charge of the Chief Engineer.

Lynchburg & Durham.—Work is being pushed on the extension of this road from Brook Neal, Va., south. The grading is nearly completed to South Boston, Va., and it is expected that the road will be completed to this place soon. The bridge at the Staunton River is completed and track has been laid to a point some 9 miles south. The work is also progressing rapidly from Durham, N. C., north.

Norfolk & Western.—This company has given a mortgage for $30,000,000 to the Central Trust Co., of New York. The mortgage covers the entire system. The object of the mortgage is to provide money to double-track portions of the road and to build extensions to Ironton, O., and to North Carolina, and to provide additional terminal facilities at Norfolk, and other improvements. Existing mortgage bonds will be retired.

Roanoke & Southern.—About 300 men are now at work on this road between Winston, N. C., and Martinsville, Va., and 28 miles will soon be in operation. The remainder of the line between the above places is being pushed forward rapidly.

Atlantic & Danville.—An engineering corps is being organized to make surveys for the Danville & East Tennessee R. R.

Kentucky Midland.—Tracklaying is in progress between Georgetown and Paris, Ky. The work is to be completed by Nov. 15.

Kentucky Union.—Mason, Hoge & Meyer, of Frankfort, Ky., the contractors, have about 1,500 men at work on the extension to Jackson, Ky. Track is being laid at the rate of one mile per day.

Louisville & Nashville.—It is stated that the Owensboro & Nashville R. R. will be extended from Adairsville, Ky., to Springfield, Tenn, 12 miles.

Projects and Surveys.

Southern Coal, Iron & Railway Co.—This company has been organized in Massachusetts to build a system of railways in Tennessee, North Carolina, and South Carolina to be known as the Blue Ridge Railway System. The road will run from Morristown, Tenn., via Kansas, Dandridge, and Severville, to a point near Maryville, thence to Madisonville and Athens, Tenn., with a division from Severville over the Blue Ridge to Knoxville and a loop to Greenville, S. C., and Augusta, Ga. Surveys are reported in progress. The company will be incorporated soon. L. C. WATKINS, of Boston, Mass., is Chief Engineer.

Memphis, Nashville & Atlantic.—A company by this name has been incorporated in Tennessee to build a railway from Nashville to Glen Mary, with a branch from the main line to a point on the Tennessee River in Rhea County. The company is also empowered to build branch roads not to exceed 30 miles in length in the counties of Overton, Putnam, Cumberland, and Fentress.

South Atlantic & Northwestern.—This road has been surveyed from Southport, N. C., to the Tennessee State line and 40 miles of the distance located. It is announced that construction will commence within one month.

West Georgia Construction Co.—This company has been organized in Georgia with G. GUNBY JORDAN, of Columbus, Ga., President, to build the Georgia & Tennessee Railway, and to do such other railway work as may come to the company.

NORTHWEST.—Existing Roads.

Chicago, Milwaukee & St. Paul.—The annual report of this company for the year ending June 30, 1889, shows the following results of operations:

Gross earnings	$25,422,559
Operating expenses and taxes	16,548,385
Net earnings	$8,874,174

President MILLER considers ill advised and restrictive legislation and the building of needless railways as the sources of the worst complications which have arisen The Interstate Railway Association has in some cases operated to the detriment of the company, but he says: "It has been demonstrated, however, to be the best form of agreement that has ever been devised, and it is hoped that the coöperation of outside lines may yet be secured so that its objects may be accomplished as nearly as practicable, and its continuance assured. It is idle to expect any association or agreement for securing stable rates to be a complete success so long as pools are prohibited. It is hoped that pools will eventually be legalized under the supervision, if need be, of the Interstate Commission, and that pool contracts will be subject to enforcement by courts."— The New Lisbon, Necedah & Lake Superior R. R. Co. has been incorporated in the interest of this company to build the proposed branch from New Lisbon, Wis., to Lake Superior, a distance of about 200 miles.

Union Pacific.—A press report states that this company has commenced construction on the cut-off from Boelus Station, on the Loup City branch up the South Loup Valley to Calloway, Neb.

Sioux City & Northern.—Tracklaying has been completed from Sioux City, north to Lester, Ia. The road will be opened to Maurice, Ia., Nov. 9. It is expected that the entire line will be completed by Dec. 1. F. C. HILLS has been appointed General Manager, with offices at Sioux City, Ia.

Duluth & Winnipeg.—About 30 miles of track have been laid on this road from Cloquet, Minn., west. Tracklaying is being pushed on the remaining 20 miles to the Mississippi River.

Winnipeg & Southeastern.—Egan Bros., the contractors are pushing work on this road from Winnipeg, Man., southeast to the International boundary. The line has been located for the entire distance and most of the right of way has been secured.

Louisville, Evansville & St. Louis.—Tracklaying is progressing on the extension from Belleville to Mt. Vernon, Ill., at the rate of one mile per day. The road is being ballasted as fast as the track is laid and it is expected that the entire line will be in operation by Dec. 1

Projects and Surveys.

St. Louis, Indianapolis & Eastern.—Chartered in Illinois to build a railway from East St. Louis, east to a point on the Indiana State line near the village of Palestine, a distance of about 148 miles, with a branch from the main line at Newton, Ill., to Effingham, Ill., a distance of 220 miles. The incorporators and first Board of Directors are: HORATIO B. GARDNER, THOMAS B. RICE, JOHN PRINDIVILLE, JOHN L. STOCKTON and IRA C. WOOD, all of Chicago.

SOUTHWEST.—Existing Roads.

Missouri Pacific.—A corps of engineers under the direction of J. C. KELTON has commenced the survey for the line from Boonville to Jefferson City, Mo. Work was suspended on this line last year on account of legal difficulties, but it is now stated that it will be resumed and the road pushed to completion.

Red River, Sabine & Western.—The engineers of this company are now locating the line between Nacogdoches and New Birmingham, Tex.

San Antonio & Aransas Pass.—Grading on the Waco extension of this road has been completed to Giddings, Tex., and tracklaying has been completed to within four miles of that place.

ROCKY MT. AND PACIFIC.—Existing Roads.

Astoria & South Coast.—Contractor Parker has about 200 men at work on this Oregon road southeast from Sackett's mill. The force is constantly being increased and the work is being pushed rapidly along.

Denver & Rio Grande.—A press dispatch states that this company is about to let contracts for the extension of the San Luis branch to a connection with the San Juan line. The proposed line will bring Denver into more direct connection with the southwest than now.

Puget Sound & Gray's Harbor.—Tracklaying on this Washington road has been completed to within 3 miles of Montesano, W. T.

Projects and Surveys.

Satsop.—Incorporated in Washington to build and equip a railway and telephone line from Hammersley Inlet to the head waters of Satsop River. Incorporators: ALFRED H. ANDERSON, BENJ. B. HEALY, CHESTER F. WHITE and JAS. R. MCDONALD.

Tacoma & Puyallup.— Chartered in Washington to build a railway from Tacoma to other points in the State. Among the incorporators are: FRANK O. MEEKER and G. W. MCALLISTER.

Oregon Western.—This company has been incorporated in Oregon to purchase the lines of the Oregonian Ry., and to acquire and build other lines of railway in Oregon. It proposes to build lines of railway, from Portland, Ore., south to Airlie, Polk County, and from East Portland southeast to Coburg, Lane County. Branch lines are projected as follows: from Silverton, Marion County, to Dundee Yamhill County; from a point on Howell's Prairie, between Silverton and Macleay, southeasterly to a point in the Waldo Hills; from a point opposite Scio, Linn County, to the town of Scio; from Broadmeads, Yamhill, in a westerly direction, to Sheridan; from a point or points on the line on this side of the river, at a suitable point near Dayton to the latter place.

Pacific, Chehalis & Eastern.—It is announced that work will soon commence on this road, which is projected to run from Pacific City, Wash, along the Willapa and Cowlitz valleys to Chehalis, Wash.

RAPID TRANSIT.

Cable Railways.— ***Bethlehem, Pa.***— The Bethlehem & Allentown St. Railway Co. has been organized to build a cable line to Rittersville and Allentown. Capital stock, $50,000.

Oakland, Cal.— Tracklaying is progressing on the Piedmont cable road. The San Francisco Tool Co. has 400 men at work along the line and 200 in San Francisco.

Elevated Railways. — ***St. Louis, Mo.***— The Rapid Transit Ry. Co.'s bond has been approved.

Pittsburg, Pa.— Philadelphia parties have obtained charters for 4 railway lines in Allegheny County. It is said they will be elevated roads, and operated by electricity.

Electric Railways.— ***Greenfield, Mass.*** — It is proposed to build a line between Greenfield and Turner's Falls. The Thomson Houston system will be used, and the cost is estimated at $5,000 per mile.

Albany, N. Y.—The Albany Ry. Co. has awarded the contracts for its new power house to Collins Bros. for mason work, and Patrick McCann for carpenter work; the building will cost $12,000. The capital stock has been increased to $75,000.

Seneca Falls, N. Y.—The Seneca Falls & Waterloo Ry. has been sold to Charles Roe, of Rochester. The road will probably be extended to Geneva and operated by electricity.

Syracuse, N. Y.—Work has been commenced on the construction of the Syracuse, Eastwood Heights & Dewitt electric road; the road will be 4 miles long. President, N. L. WILLIAMS; Vice-President, R. N. GERE; Secretary, GEORGE B. LEONARD.

Richmond, Va.— It is proposed to build an electric road to Petersburg.

Nashville, Tenn.—All the street railways have been consolidated under one company with a capital stock of $3,000,000, and all of them will be operated by electricity.

Akron, O.—A local syndicate has purchased the stock of the Akron Electric St. Ry. Co. held by Cleveland parties. Mr. SEIBERLING is at the head of the new company and has ordered 10 cars from the Pullman Car Co. and 2 dynamos from the Edison Co., of New York.

Cincinnati, O.—The Cincinnati St. Ry. Co. has been granted permission to adopt electric traction on some of its lines. The tracks are to be laid with 52-lb. side-bearing girder rails and iron poles are to be used to carry the overhead wires.

Chicago, Ill.—The Chicago Electric Ry. Co. has been organized by O. M. BRADY, T. P. HICKS and CHAS. F. SWIGART. Capital stock, $1,000,000.

Springfield, Ill.—The street railway will probably be purchased by outside capitalists, who propose to operate the lines by electricity.

Stillwater, Minn.—The electric railway to South Stillwater has been opened for traffic. It is 4 miles long.

Seattle, Wash.—The Jackson County Electric Ry. Co. has been incorporated by W. W. KIRKWOOD, W. H. LLEWELLYN and C. J. EDDY. Capital stock, $50,000.—The Seattle Electric Ry. & Power Co. will build the Green Lake line. J. H. McKay has the contract for grading.—The Seattle & Tacoma Ry. Co. has been incorporated by CHAS. H. FRENCH, ANGUS MACKINTOSH, T. F. THOMPSON, and others, to build an electric road between the two cities. Capital stock, $600,000.

Toronto, Ont.—The charter of the Toronto St. Ry. Co. will expire shortly, and it is suggested that the city should adopt an electric system and operate the line for itself.

Street Railways.—***Brooklyn, N. Y.***—The Brooklyn City Ry. Co. has leased 5 more lines and will extend its Flushing Ave. line. About $1,000,000 will be spent in improving the old and new lines, but not for changing the motive power on any part of the system.

Philadelphia, Pa.—The Catharine & Bainbridge St. Ry. Co. has been granted a franchise and right of way.

Canton, O.—The Canton & Lakeside Ry. Co. has increased its capital stock to $1,500,000 and will build an extension to Massillon.

Indianapolis, Ind.—A company is being organized to introduce the Judson system of traction. Mr. J. C. SHAFFER, President of the street railway company is interested.

Pella, Ia.—A street railway is to be built. It will be operated by dummy engines.

Mexico, Mo.—The street railway company having abandoned its project, the City Council is said to have ordered the tearing up of the tracks.

Kansas City, Kan.—The elevated railway company proposes to operate the Riverview line by steam motors instead of cable as at present.—The Consolidated City & Chelsea Park Ry. Co. has been incorporated by D. M. EDGARTON, W. E. BARNHART, and D. E. CONNELL. Capital stock, $100,000.

Clayton, Mo. — The St. Louis County St. Ry. Co. will build a line on the St. Charles road. The plans have been approved by Mr. RAPP, Road Commissioner.

Houston, Tex. — The Bayou City Ry. Co. has been granted a right of way.

Aspen, Col. — The street railway franchise has been purchased by R. S. RYAN, of Denver, who will build a line 2 miles long.

Santa Rosa, Cal. — A street railway franchise has been granted to F. A. BECKET, G. BRIGGS, and A. P. OVERTON.

Tacoma, Wash. — The Southern St. Ry. has been incorporated by R. F. RADEBAUGH, THEO. HORNER, and F. O. MEEKER. Capital stock, $100,000.

Port Townsend, Wash.—The Port Townsend Construction & St. Ry. Co. has been organized; it has purchased the 4½ miles already built and is making extensions. President, R. C. HILL; Vice-President, B. S. MILLER; Secretary, H. L. BURKETT. Capital stock, $100,000.

Seattle, Wash. — The Ranier Power & Ry. Co. has been incorporated by GEO. KINNEAR, R. S. GREENE, and JOHN B. DENNY to build cable and electric roads. Capital stock, $100,000.

Spokane, Wash.—The Spokane Ry. Co. has been reorganized with ALFRED S. MOORE, of San Francisco, at its head. Cable or electric traction may be introduced.

HIGHWAYS.

Maryland.—The subject of better roads is being freely discussed in all sections of Baltimore County, and everybody wants some improved method by which better results will follow the expenditure of so large a sum of money as is annually assessed on account of the general and special road and bridge account. There is a general commendation on the part of farmers of the efforts made to secure better thoroughfares, and to awaken a general interest throughout the county in this important subject. At the meeting of the Baltimore County Grange, held at Towsontown, the subject of better roads and low taxes was discussed, and resolutions adopted expressive of the action they desire the Legislature to take at its next session to accomplish what is desired by the farmers as well as other taxpayers. The Grange held a public meeting, at which the road and tax subject was open for general discussion. The farmers recognize the necessity of some improvement, and HENRY S. WRIGHT, a farmer and road supervisor of the Seventh District, is reported as saying that there ought to be some way adopted to secure better roads. The present system is a constant filling in and washing out. He says he had been a road supervisor for fifteen years, and the roads are now in a worse condition than they have ever been, owing to so much wet weather.

CONTRACTING.

Ditch and Tunnel.— The following proposals have been received by the Citizens' Water Co., of Denver, Col. Mr. CHAS. P. ALLEN is Constructing Engineer, and Mr. RICHARD HOLME, Secretary. For ditch 5 ft. deep and 5 ft. 9 ins. wide at top: J. A. Osmer, 17½ cts. per lin. ft.; Pat Ford, 17½ cts.; Ballard, Grady & Co., 17½ cts.; G. W. Harriman, 18 cts.; Daniel Dennis, 18 cts.; Foley Bros., 18½ cts.; Mead & Howards, 19½ cts. per cu. yd.; Oscar Allen, 20 cts. per lin. ft.; Moore & Clough, 20 cts.; Wicks & Co., 21 cts. per cu. yd.; Christie & Lowe, 29 cts. per lin. ft.; P. J. Riley, 30 cts. per cu. yd.; D. E. Rich, 30 cts. per lin. ft.; John Peters & Co., 33 cts. The contract was awarded to J. A. Osmer at 17½ cts. per lin. ft. For tunnel 1,700 ft. long, 42 ins. diameter, cemented: F. H. Strong, $4 per lin. ft.; Chas. E. Higbee, $4; Cole & Allen, $4; Foley Bros., $4.70; Christie & Lowe, $5.40; Chas. Schafer & Co., $6; Ballard & Haule, $8.50; C. O. Inman & Co., $9.75. The contract was awarded to Frank H. Strong at $4 per lin. ft.

Railway Work.—The contract for grading the Kennebec Central R. R. has been awarded to Michael O'Neil, of Cumberland Mills, Me., at the following prices: earth, 24 cts. per cu. yd.; loose rock, 60 cts.; solid rock, $1.50; clearing and grubbing, $40 per acre; culvert masonry, $3.50 per cu. yd.; paving, $1.75; rip rap, 75 cts. per cu. yd.

Machine Shop.—The Water Board, Boston, Mass., has received the following proposals for the construction of a new machine shop: Kelly & McKinnon, $46,675; Howard Coon & Co., $46,695; G. Currier & Co., $49,053; R. R. Mayers & Co., $49,339; S. Brennan & Co., $49,508.75; Thos. J. Lyons, $50,805; W. A. & H. A. Root, $50,957; D. H. Jacobs & Son, $51,410; B. F. Dewing, $51,600; L. C. Knight, $52,500; Keening & Strout Bros., $52,728.

Sewage Pumps.—The following were the bids received by the City Council of Salt Lake City, Utah: The Utah & Montana Machinery Co. offered to take the order for an engine, charging the city 5 per cent. commission on the net cost proposed by the pump company. The Westinghouse engine to drive the pump would cost $350 delivered in Salt Lake City, blue print accompanying.

Jones & Jacobs, Salt Lake City, offered a Worthington compound pumping engine, 1,000 galls. per minute, $3,965, delivered.

The Knowles Pump Co. offered a sewage pumping engine weighing 33,000 lbs., giving 1,000 galls. per minute against a 55-ft. lift, and running at a piston speed of 62 ft. for $4,597. If special acids from manufacturing establishments or anything of that kind come into the sewage, add $780 to the above bid.

Dredging.—The Grand Isle Ry. Co. proposes to dredge a channel to shorten the route from its terminus on the Locola Canal to Grand Isle, La.

The following proposals for dredging at Raleigh, Ont., were received Nov. 2, by A. MCDONELL, C. E., of Chatham, Ont.: S. T. Martin, of the Chatham Dredging Co., $43,000; McCallum & Lee, Welland, Ont., $48,800; J. & T. Conlon, Thorold, Ont., $50,000; Angus Sinclair, Chatham, $54,000: Manning & McDonald, Toronto, Ont., $69,000, including the construction of four bridges. The contract was awarded to the Chatham Dredging Co.

Sewer.—***Baltimore, Md.***—The City Commissioner has awarded contracts as follows for materials for the Pulaski St. sewer: stone to John G. Schwind at $1.53 per cu. yd.; sand to Morgan & Bressman at 85 cts. per cu. yd.; handmade brick to Frederick Rice at $8.95 per 1,000, machine-made to James R. Busey & Son at $8.50 per 1,000. The bids for sewer blocks were all rejected, and the City Commissioner has readvertised for proposals.

Paving Blocks.—The New York & Maine Granite Block Paving Co. has shipped from Portland, Me., to New York, 1,200,000 paving blocks during the past season. The blocks are cut in North Conway and North Jay and brought over the Maine Central R. R. direct to the company's wharf. The company has a contract with New York city for 10,000,000 of these blocks.

Street Work.—***Newark, N. J.***—The contract for trap block paving on Prince St. has been awarded to B. M. & J. F. Shanley at $2.49 per sq. yd.

Baltimore, Md.—The City Commissioner has received the following proposals for grading an alley; Thomas F. Locke, for grading, per cu. yd., 30 cts.; paving, per sq. ft. 6¾ cts. Morgan & Bresnan, for the same, 19½ and 5½ cts.; Michael O'Neil, 9 and 6 cts.; George Utterbaugh, 25 and 6 cts.; Patrick Kelly, 15 and 7 cts. The contract was awarded to Michael O'Neil.

Washington, D. C.—The District Commissioners have

awarded the following contracts. C. B. Pearson, to remove 10,000 cu. ft. of earth from New Hampshire Ave. at 10 cts. per cu. yd.; F. B. Noyes, to grade not more than 10,000 cu. yds. of 6th St., at 10 cts. per cu. yd., and A. A. Thomas, to grade 10,000 cu. yds. of Quincy St. at 10 cts. per cu. yd.

Kansas City, Kan.—A contract for cedar block paving has been awarded to Jaicks & Robinson at $1.57 per sq. yd.

Oakland, Cal.—The Trustees have awarded the contract for paving 8th St. with bituminous rock to the San Luis Obispo Paving Co., for $11,304.

Steel for the Cruisers.—Bids were opened Oct. 31 in the office of the Secretary of the Navy for furnishing steel for the 3,000-ton cruisers, which the Government will build at the New York and Norfolk Navy Yards respectively. The material is to be furnished in six classes, as follows: (A) 672 tons thin plates; (B) 190 tons thick plates; (C) 10 tons wrought steel; (D) 106 steel shapes; (E) 70 tons rivets; (F) 83 tons of castings. This amount is for each of the cruisers. The bids were as follows for each of the cruisers: Standard Steel Casting Co., Thurlow, Pa., Class F, $31,606.40. Oliver Iron & Steel Co., Pittsburg, Pa., Class E, $7,840. Linden Steel Co., Pittsburg, Pa., Class A, $71,500.80; Class B, $27,664. Carnegie, Phipps & Co., Limited, Pittsburg, Pa., Class A, $65,856; Class B, $30,856; Class C, $20,160. Bethlehem Iron Co., South Bethlehem, Pa., Class C, $7,476.

Sewer.—***Boston, Mass.***—The following proposals were received by the City Engineer Nov. 4 for the construction of Section 3, Dorchester intercepting sewer, of the improved sewerage work. The contract was awarded to Aaron A. Hall.

Bidders.	Earth Excavation and Refill. in Trench. 2,000 lin. ft.	Brick Masonry, American. 730 cu. yds.	Brick Masonry, Portland. 20 cu. yds.	Concrete. 225 cu. yds.	Rubble Stone Masonry. 240 cu. yds.	Spruce Lumber. 27 M. ft. B. M.	10-in. Drain Pipe. 2,000 lin.ft.	Spruce Piles. 100 in all	Total.
Aaron A. Hall, Boston	$6.50	$12.88	$15.90	$6.00	$6.00	$26.00	$0.60	$5.00	$28,731.40
Dennis O'Connel, Boston	7.50	13,35	15.25	5.75	5.00	28.50	0.55	2.75	30,585.75
Metropolitan Construction Co., Boston	8.15	12.75	14.75	6.45	6.05	33.00	0.50	2.55	31,923.75
National Construction Co., Boston	9.55	12.17	14.30	4.65	5.23	27.00	0.45	3.00	33,540.05
J. Killian & Neil McBride	10.00	14.00	14.00	6.00	6.00	25.00	0.80	4.00	37,117.00
Collins & Ham, Boston	12.00	13.50	15.25	5.50	6 00	30.00	0.65	1.00	41,251.00

Levee Work.—The Board of Mississippi Levee Commissioners has awarded contracts as follows: E. Heyner, from Waxhaw to Hartin, 40,000 yds. at 14 cts.; below Rosedale, 3,370 yds. at 18 cts.; Melrose front, 10,000 yds. at 16 cts.; Storms front, 5,540 yds. at 18 cts.; Bolivar to Edmonds, 10,700 yds. at 22 cts.; Choctaw Bend levee, 33 260 yds. at 17 cts. Easterling & Aldrich, Greenville to Warfield, 3,000 yds. at 10 cts., and 17,000 at 15 cts. W. R. Harvey & Co., above Session's Gate, 30,260 yds. at 17 cts.; Rivington to Buleaugh, 29,260 yds. at 6 cts. J. S. Gant, Bell front, 9,120 yds. at 16¾ cts.; P. F. Lamb, Franklin's to Rowland, 21,880 yds. at 16 cts.

Asphalt Paving.—***New York, N. Y.***—The contract for asphalt paving on Madison Ave. has been awarded to the Sicilian Asphalt Paving Co.

Kansas City, Mo.—For paving Forest Ave. the Barber Asphalt Paving Co., of New York, bid $2.80 per sq yd., and the Western Paving Supply Co., of Chicago, $2.60

Newark, N. J.—The contract for asphalt paving on Orchard St. has been awarded to the Barber Asphalt Paving Co. at $2.93 per sq. yd. The Warren-Scharf Co. bid $3.20, and the Newark Asphalt Co. $3.15.

PROPOSALS OPEN.

Railway.—Two sections of grading, five miles each, on the Baltimore & Eastern Shore Ry. Godeffroy & How, Easton, Md.

Bridge—Iron bridge, 280 ft. span, across the James River. E. Palmer, County Engineer, Yankton, Dak. Nov. 11.

Highway.—Grading, straightening and improving the Bear Swamp road. W. H. Birchall, Commissioner of Improvements, West Chester, N. Y. Nov. 11.

Concrete Pavement.—Laying Taylor's granolithic pavement, or a pavement of equal quality, around Tompkins Park. Robert Courtney, Secretary, Park Commissioners, City Hall, Brooklyn, N. Y. Nov. 12.

Railway.—Grading about 8,700 ft. of roadbed, comprising about 65,000 cu. yds. of earth excavation, in Polk County, Ga. Specifications at the office of Geo. H. Clark, Chief Engineer, Cedartown Ga. Charles P. Ball, Manager East & West R. R. of Alabama, Cartersville, Ga. Nov. 12.

Sheathing.—Sheathing the pier at the foot of Noble St. J. P. Adams, Commissioner of City Works, Municipal Building, Brooklyn, N. Y. Nov. 12.

Piers.—Removing piers in Gowanus Creek. D. A. Nash, Secretary Board of Pilots, 40 Burling Slip, New York. Nov. 12.

Street Work.—Grading, cobblestone paving and flagging. J. P. Adams, Commissioner of City Works, Brooklyn, N. Y. Nov. 12 and 13.

Sewer Blocks.—For the bed of the Pulaski St. sewer. A. E. Smyrk, City Commissioner, Baltimore, Md. Nov. 13.

Bonds.—Water-works bonds for $20,000. F. Barnckoff, McMinnville, Ore. Nov. 15.

Sewers.—Vitrified pipe 12 and 18-in., Ys, manholes and lamp holes. T. J. Lanahan, Clerk of Board of Contract, Albany, N. Y. Nov. 18.

Paving.—Asphalt pavements on concrete foundations; asphalt pavement on present macadam pavement; granite block pavement on concrete foundation. The Commissioner of Public Works, 31 Chambers St., New York City. Nov. 18.

Street Work.—Macadamizing and grading Main St. F. J. O'Flaherty, County Surveyor, Water-Works Building, Kansas City, Mo. Nov. 21.

Lumber.—At the Norfolk navy yard; 63,000 ft. white pine lumber, 120 cypress poles and 280 juniper shores. James Fulton, Paymaster General, U. S. N., Navy Department, Washington, D. C. Nov. 26.

Bridge Approach.—Iron approach to bridge, length 410 ft.; 16 ft. roadway, 8 ft. sidewalk. Cedar block paving. Plans and specifications to be furnished by the bidders. Geo. C. Shelden, Houghton, Mich. Dec. 1.

Jail.—Addition of 4 cells and corridor to jail at Orlando. B. F. Whitner, Chairman County Commissioners, Orlando, Fla. Dec. 2.

Sewers.—Trunk sewers in Lick Run. Thos. G. Smith President Board of Public Affairs, Cincinnati, O. Dec. 5.

MANUFACTURING AND TECHNICAL.

Market Prices.—***Rails.***—New York and the East; mill prices, $31.50 to $32,50 per ton. Pittsburg; mill prices $33 to $33.50 for heavy sections. Chicago; $35.

Track Material.—New York; spikes, $2.15 to $2.25; angle bars, 2.05 to 2.15 cts.; bolts, 3 to 3.25 cts. Pittsburg: spikes, 2,10 cts. at mills, or 2.20 cts. at Chicago, St. Louis or Cincinnati; splice bars, 2 cts.; track bolts, 3 cts. with square or 3.10 cts. with hexagon nuts. Chicago; spikes, 2.20 to 2.40 cts.; splice bars, 2,15 to 2,20 cts. for steel and 1.97½ to 2,05 cts. for iron; track bolts, 2.80 to 2.85 cts. for square and 2.90 to 2.95 for hexagon nuts.

Structural Material.—New York, prices on dock; angles 2,10 cts. to 2.25 cts.; tees, 2.6 cts. to 2.7 cts.; beams and channels, 3,1 cts. In plates, iron is 2.15 cts. to 2.20 cts, steel tank, 2.45 cts, 2.5 cts.; ship, 2.5 cts, 2.6 cts.; shell, 2.; cts. 2.9 cts; flange, 3,10 cts.; fire-box, 4.25 cts. to 4.40 cts. Bars: common, 1.7 cts.; medium, 1.75 cts. to 1.85 cts; refined, 1.85 cts, to 2 cts; hoops, 2.2 cts.; galvanized sheets, 65 per cent.—Pittsburg; angles, 2.35 cts.; tees, 2.85 cts.; channels, 3.10 cts.; sheared steel bridge plates, 2.70 cts.—Chicago; angles, 2,35 cts. to 2.45 cts.; universal plates 2.50 cts.; sheared plates, 2.60 cts. to 2.70 cts.; tees, 2.90 to 3 cts.; beams and channels, 3.20 cts. Small lots from store are quoted at 2.60 cts. for angles, 3 cts. for tees and 3.70 cts. for beams and channels.
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Railway Plant.—The Industrial Works, Bay City, Mich., report among recent shipments two of their standard extension pile drivers, one to the Chicago & Atlantic, and the other to the Mexican Central road; also one of their newly designed 35-ton wrecking and construction cranes to the Kansas City, Ft. Scott & Memphis R. R. This crane has a steel car mounted upon three heavy trucks, a powerful engine, boiler, and hoisting machinery, ponderous steel jib, and is, perhaps, the most complete tool for this kind of service ever constructed in this country. The company is at present engaged upon a portable steel rail cutting-off saw for the Canadian Pacific. This will include, in addition to the cold saw proper, a double cylinder high-speed driving engine, rail drill, feed table, and all the parts necessary for a complete equipment for this work. Also an electric transfer table 60 ft. long, and of the largest capacity, for the new shops of the Union Pacific road at Cheyenne; two 20-ton steel transfer cranes and one 20-ton steel pillar crane for the Detroit yards of the Michigan Central; and a 15-ton steel pillar crane for the Cincinnati, Hamilton & Dayton. In addition to these the works have about completed an extension pile driver for the Duluth & Iron Range road, and have under way a large 30-ton steam wrecking and construction crane for the Savannah, Florida & Western, and a turntable for the shops of the Toledo, Ann Arbor & North Michigan road at Clare. A recent order from the Cambria Iron Works of Johnstown, Pa., calls for a portable steel crane and car 15 tons capacity; and other extensive orders, not yet placed in the shops, will keep this company busy for several months to come.

Railway Plant and Machinery Wanted.—Rails spikes, splice bars, bolts, etc.; also engines and cars. St. Albans & Coal River Ry. Co., St. Albans, W. Va.

Material for logging railways. Alabama Land & Lumber Co., Birmingham, Ala.

About 70 tons of good steel rails, about 50 lbs. Waterous Engine Works Co., Brantford, Ont., Canada.

Light cars, new or second-hand. D. A. Miller, Secretary, Ocala St. & Suburban Ry. Co., Ocala, Fla.

Second-hand engine for driving electric light plant; 10, to 15 H. P. G. S. *Globe Democrat* office, St. Louis, Mo.

Second-hand engine; cylinder 14 to 16 ins. diameter. E. B. Lanman, Columbus, O.

One 4 H. P., one 12 H. P. vertical engine and one 40 H. P. vertical boiler. M. 122, *Sun* office, Baltimore, Md.

Gas engine, about 4 H. P. M. W., 1,004 26th St. N. W., Washington, D. C.

Locomotives.—The Rogers Locomotive Works, of Paterson, N. J., have an order for 10 consolidation freight and 10 switching engines for the Louisville & Nashville.

The Baldwin Locomotive Works, of Philadelphia, Pa., have an order for 10 consolidation engines, with cylinders 20 x 24 ins., for the Denver, Fort Worth & Texas.

The Brooks Locomotive Works, of Dunkirk, N. Y., are building 10 moguls and 5 switching engines for the Cleveland, Cincinnati, Chicago & St. Louis. Also 7 eight-wheel and 8 ten-wheel engines for the Montgomery-Tuskaloosa & Memphis.

The Schenectady Locomotive Works, of Schenectady, N. Y., have built 13 consolidation, 7 eight-wheel passenger and 2 switching engines for the East Tennessee, Virginia & Georgia. The passenger engines have cylinders 18 x 24 ins., and driving wheels 68 ins. diameter.

The Pennsylvania Railroad Co. has placed orders for 25 locomotives.

Locomotive Works.—A Belgian firm is said to propose to establish locomotive works at St. Hyacinthe, Que. The city will grant land for a site and also a subsidy of $50,000.

The Baldwin Locomotive Works, of Philadelphia, Pa., are said to have purchased 700 acres of land at Saltsburg, Pa., for extensive works, its present works at Philadelphia being crowded.

Cement.—The following mixture is said to make a cement which will resist heat; 10 parts of iron filings, 5 of clay, 2 of quartz sand, and 1 of common salt.

Pipe.—The Oregon Iron & Steel Co., of Portland, Ore., has been shipping 20 tons of cast-iron pipe and 20 tons of pig-iron per day to San Francisco.

Grate Bars.—The Culm-Burner Grate Bar Co. has been incorporated at Chicago by Wm. Siebert, Henry Peterson and Fred Connors. Capital stock $100,000.

Compound Locomotive.—The Schenectady Locomotive Works, of Schenectady, N. Y., are building a mogul compound locomotive.

Car Coupler.—The Automatic Interchangeable Car Coupling Co. has been organized at San Francisco by J. S. Fillmore, H. J. Smell, and F. A. Fox. Capital stock $1,000,000.

Air Brakes.—The Park Air Brake Co., of Chicago, is said to have filed a certificate of dissolution.

Garbage Crematories.—A vote will be taken Nov. 23, on a proposition to issue bonds to build a crematory at Waycross, Ga.—A crematory is also to be built at Vancouver, B. C., address Mr. Mohun, Sanitary Engineer.

The Union Southern Construction Co. has been incorporated at Chicago, Ill., by Alfred Cowles, Jr., Albert E. Rawson and J. Bramball. Capital stock, $100,000. The company proposes to build railways.

Cars.—The Laconia Car Co., of Laconia, N. H., has completed 100 Eastman heater cars for the Boston & Maine, and are building 5 passenger cars for the same road.

The Centropolis Car & Machine Works, of Centropolis, Kan., are building street cars for Hastings, Neb. The company makes a specialty of street and cable cars.

The Terre Haute Car & Mfg. Co., of Terre Haute, Ind., has an order for 500 coal cars for the Chicago & Northwestern.

The Lebanon Mfg. Co., of Lebanon, Pa., has an order for 200 gondola cars for the Huntington & Broad Top Mt.

The Pennsylvania Railroad is having built 2,000 box cars of 60,000 lbs. capacity.

The Richmond & Danville Railroad has filed a mortgage for $2,500,000, the money to be spent in rolling stock equipment and general improvements.

Projectiles.—The Roberts Projectile & Mfg. Co. has been organized at Washington, D. C., and incorporated

in Virginia, with a capital stock of $1,000,000, to manufacture a new projectile invented by ROBT. R. ROBERTS. President, R. R. ROBERTS, Washington, D. C.; Vice-President, M. V. BARLEY; Secretary, K. S MURCHISON.

Steel Working.—A new process in steel manufacture is to be tried at the works of the Hematite Steel Co., at Barrow, England. Instead of cogging or hammering the ingots into the form of slabs, the operation will be performed by an hydraulic press. The advantages claimed for the new method are that the slab so made will be more homogeneous, and the metal generally of superior quality to that turned out by the system now used

Interlocking.—The Kansas City Frog & Switch Co. has completed the interlocking plant at Westminster where the Independence Rapid Transit Ry. crosses the New Winner Belt Line & Terminal Ry.

Asphalt.—The Tabor Investment Co., which has taken hold of the Western Colorado and Eastern Utah asphalt beds, has sent out an expert to make an investigation, and upon his report, if it be favorable, the company will proceed at once to the erection of a grinding and mixing factory in Denver. It is claimed that this asphalt is equal to the best from the Trinidad islands, and that it will form the basis of a pavement which can be laid more cheaply than any other.

Station Indicator.—The Central Railroad of New Jersey is trying an electric station indicator on two of its trains, between Jersey City and Wilkesbarre. There is a roll in the front of each car containing the names of the stations in black letters, and these are regulated by the baggage master, who simply presses an electric button in the baggage car, where the battery is. An electric bell attracts the attention of the passengers to the signs.

Steel Car.—The Pennsylvania R. R. Co. is said to be making experiments with a car built entirely of iron and steel; the floor beams and upper frames being of steel, with wrought iron plate panels for the sides and ends. The section is of horseshoe shape, the roof being round. Artificial ventilation is provided for.

Hyatt Filters.—The Planters' Sugar Refining Co., of New Orleans, La., has ordered two large size Hyatt filters in addition to the two now in operation at their works. The Pennsylvania Reform School, Morganza, Pa., has ordered a large plant, and Harrison, Frazier & Co., Philadelphia, have ordered a fifth large size filter.

English, Morse & Co., of Kansas City, Mo., have sold Lidgerwood hoisting engines and boilers within the past month to the following parties: Missouri River Impt. Co.; F. M. Sharp, contractor for the new Bullene, Moore & Emery Building, Kansas City; Bethune & Craney, of St. Louis, Mo.; for bridge work; Missouri Valley Bridge Co., of Leavenworth, Kan., and three outfits to the National Construction Co., of Natchez, Miss., also one outfit to David Boaz of Prescott, Ariz., and one to Chas. Bradshaw of Kansas City. They have also sold special centrifugal pump outfits to Chas. Hoff & Co., of Wichita, Kan., and J. J. Hiem, of Ft. Smith, Ark. The firm carries a large stock of Lidgerwood engines here in stock and can make immediate delivery.

BRIDGES AND CANALS.

Bridge Notes.—*Providence, R. I.*—The following proposals have been received by the City Engineer for an iron bridge at Manton Village: Milliken Bros., New York, $3,403.83; Groton Bridge Co., Groton, N. Y., $4,100; R. F. Hawkins, Springfield, Mass., $4,192; Boston Bridge Works, Boston, Mass., $4,331; Dean & Westbrook, New York, $4,500; Wrought Iron Bridge Co., Canton, O., $4,500; King Iron Bridge Co., $4,515; Vermont Construction Co., St. Albans, Vt., $4,668; Penn Bridge Co., Beaver Falls, Pa., $4,700; James H. Tower, Providence, $4,839; John Garver, Providence, $5,275; J. E. Buddington, New Haven, Conn., $5,256; T. J. Obert, Union Boiler Works, Reading, Pa., $6,550. The contract was awarded to Milliken Bros.

Brooklyn, N. Y.—The stone bridge over the Gowanus Canal at Third St. has been completed.

Ellicott City, Md.—The Groton Bridge Co., of Groton, N. Y., has built an iron bridge over the Patuxent River, at a cost of $1,900.——Cofrode & Saylor, of the Philadelphia Bridge Works, will build an iron bridge 190 ft. span over the same river.

Point of Rocks, Md.—The Frederick Bridge Co. has completed its bridge over the Potomac River; it was built by the Smith Bridge Co., of Toledo, O., and cost $46,000. It is 1,460 ft. long, with eight spans, and the floor is 40 ft. above the water.

Covington, Ky.—The Cincinnati & Newport Bridge Co. will spend $100,000 in improvements.

Danville, Ill.—All the bids for the iron bridge have been rejected. For particulars address ALEX. BOWMAN, City Engineer.

Venice, Ill.—Work is in progress on the approaches of the Merchants' Bridge, and the false work is being erected on the west side.

Minneapolis, Minn.—The following proposals have been received for the steel arch bridge: Massillon Bridge Co., Massillon, O., $59,330 with oak floor, $60,941 with iron floor; Mt. Vernon Bridge Co., Mt. Vernon, O., $59,988, $67,893; King Iron Bridge & Mfg. Co., Cleveland, O., $61,-999, $74,800; Chicago Bridge Co., $64,994, $72,994; Wrought Iron Bridge Co., Canton, O., $64,422, $72,881; Milwaukee Bridge Co., $69,750, $78,705; Smith Bridge Co., Toledo, O., $69,875, $73,500; Shiffler Bridge Co., Pittsburg, Pa., $69,-400, $78,300; Keystone Bridge Co., Pittsburg, Pa., $74,900, $83,900. For removing the old bridge and building the substructure of the new one, Arthur McMullin bid $4,000.

Kansas City, Mo.—Propositions for building the pontoon bridge across the Missouri at Randolph Point have been made by L. M. STEWART, of Kansas City, Kan., and VINTON STILLING, of Leavenworth.

Wyandotte, Kan.—The Secretary of War, at Washington, is said to have finally rejected the plans of the Kansas City Bridge Co. for the proposed new bridge across the Missouri River at Wyandotte. The plans were first rejected because they had not been submitted for approval within the specified time, one year from the date of the passage of the act authorizing the construction of the bridge. An appeal was taken and another objection was found, it being shown that the proposed location of the bridge was not in accordance with the terms of the bill. The bill provided that one terminus of the bridge should be in Jackson County, Mo., but the plans were drawn so that one terminus was in Clay County, Mo., and the other in Wyandotte County, Kan. This being fully established, the Secretary felt compelled to reject the plans, and the bridge company will now have to await further legislation by Congress.

Bastrop, Tex.—A bridge is to be built across the Colorado River at a cost of $50,000.

Toronto, Ont.—York and Etobicoke townships propose to build a bridge across the Humber River.

Kansas City, Mo.—The contract for the bridge over the Kaw River at So. 8th St. has been awarded to the Youngstown Bridge Co., of Youngstown, O., at $51,050. The contract for the grading was awarded to Mr. T. C. Foster, of Kansas City, at 17¾ cts per cu. yd. or about $1,5 0 for the entire grading. This will make a total expenditure for the structure of $5[illegible],550, which is $7,450 less than the appropriation ordered by the Legislature by special act last spring. The bridge proper will be 775 ft. long, with approaches, making the full length of the entire structure 975 ft. There will be three deck spans 200 ft. in length and one span of 175 ft. The roadway will be 20 ft. wide. The deck span will form a viaduct over the Santa Fé tracks. The bridge will be completed within six months after signing the contract. A proposition has been made by the Mardis-Thaver Co. to pay $10,000 of the cost of the structure in consideration of the granting of a right to use the bridge for a double track street railway line, but as yet the county board has taken no action upon the matter. The following is a list of the bids:

Detroit Bridge & Iron Co.	$102,500
St. Louis Bridge & Iron Co.	57,200
A. McLouth, McLouth, Kan.	57,000
Wrought Iron Bridge Co., Canton, O.	56,570
Smith Bridge Co., Toledo, O	56,350
King Iron Bridge Co., Cleveland, O	56,157
Milwaukee Bridge Co	56,275
Missouri Valley Bridge Co., Leavenworth	51,450
Lane Bridge & Iron Works, Chicago	52,018
Kansas City Bridge & Iron Co.	53,450
George R. King & Co., Des Moines	52,191
Youngstown Bridge Co.	51,050

Viaduct.—*Jacksonville, Fla.*—A viaduct is to be built at Bridge St., crossing the railway tracks. It will be of steel and will cost $40,000, the cost being divided between the railway companies, the street railway company, and the city. The street railway will run over the structure.

Canals.—*New York State.*—An act has been passed authorizing the construction of a dam 20 ft. high in the Black River, at Forestport, N. Y., to form a reservoir to store water for canal purposes.

Long Island.—The project of constructing a canal to unite Jamaica Bay with Rockaway Inlet is again revived, after lying dormant for more than sixty years; Mr. JOHN L. B. NORTON, of Woodsburg, being the leading spirit in the movement. By his energy and enterprise he has awakened public interest in the project and has enlisted the sympathies and coöperation of a number of wealthy and influential gentlemen. The ultimate object is to connect the south side of Long Island by water with the city of New York, the system starting at Peconic Bay and extending through Shinnecock Bay and eventually to New York Harbor.

Hudson & Niverville Ry.—The contract for the bridges on this New York road has been awarded to J. M Brosman of New York.

Lonaconing, Md.—The County Commissioners, at Cumberland, recently received proposals for the construction of two bridges and stone abutments for one bridge. The contracts for superstructures were awarded to the Variety Iron Works, of Cleveland, O., their bid being for the 56-ft. span skew bridge, with a 16-ft. roadway, $730; for the 85-ft. span wrought-iron high truss bridge, with a 14-ft. roadway, $1,495. The other bids were as follows: Beaver Falls Bridge Co., for the skew bridge, $700; for the truss bridge, $1,520. The Wrought Iron Bridge Co., for the skew bridge, $780; for the truss bridge, $1,510. Columbia Bridge Co., skew bridge, $705; truss bridge, $1,500. Berlin Iron Bridge Co., skew bridge, $800; truss bridge, $1,590. King Iron Bridge Co., skew bridge, $750; truss bridge, $1,490. Pittsburg Bridge Co. offered to put up the two bridges for $2,250. The contract for the abutments was awarded to Lloyd Durst: For excavating, 50 cents per sq. yd; rough part of the abutment to the surface, $3.50 a perch; above surface, cut stone bedded and jointed, pitch face with a not less than 12 in. course laid in cement, $6 per perch; wing walls, dry work, $3 per perch, filling 40 cts. per yd.

ELECTRICAL.

Electric Lighting.—*Swanton, Vt.*—A local company has been organized with a capital stock of $20,000.

Bristol, N. H.—An electric light plant is to be put in; $5,000 have been subscribed already.

Laconia, N. H.—The Winnipiseogee Gas & Electric Light Co. has been organized by JOHN S. CRANE, B. F. DRAKE, F. M. ROLLINS and others. Capital stock, $50,-000.

Huntington, N. Y.—The Empire Gas & Electric Light Co. has been incorporated by GEORGE OLNEY, H. L. VANSYCKLE, and C. A. GODLEY. Capital stock, $200,000.

Chatham, N. Y.—The Chatham Electric Light Co. has been incorporated by JAMES MOREHOUSE, of Chatham; CLARENCE R. DEAN and A. M. CARD, of New York. Capital stock, $15,000.

Centerville, Md.—The town authorities propose to put in an electric light plant. For particulars, address W. F. HARMAN.

Lynchburg, Va.—The following bids for 144 electric lights were received by J. D. SULLIVAN, Chairman of the Committee on Lights: Mars Construction Co., Westinghouse system, Pittsburg, Pa., 30 cts. per light per night; Peter Gatty & Co., Lynchburg, Va., leave adoption of any system to commissioners, 29 cts. for 140, and all over 25 cts.; Piedmont Illuminating Co., W. W. FLANNAGAN, President, New York City, 33 cts.; T. H. Serotam, Schuyler Illuminating Co., agent, J. W. Cox, Washington, D. C., 27 cts.

South Pittsburg, Tenn.—The South Pittsburg Electric Light & Power Co. will put in a Thomson-Houston incandescent plant.

Louisville, Ky.—Bids for electric lighting have been made by the Brush Electric Co., the Louisville Gas Co. and the Gaynor Electric Light Co.

Lexington, N. C.—J. L. PEACOCK wants information as to electric light plants for street lighting.

Florence, S. C.—W. H. BARRINGER will light the city with 60 incandescent lights of 30 c. p. each, for $900 per year, if the authorities grant him an exclusive franchise and exemption from taxes for 25 years.

Charleston, S. C.—Contracts for lighting have been awarded to the Charleston Light & Power Co. for 100 arc lights at $100 each and to the Charleston Gas Co. for 810 street lamps, at $13,464: the price for gas for the public buildings to be $1.75 per 1,000 ft.

Jeffersonville, Ind.—The Electric Light, Gas & Heating Co. has taken a contract for lighting the city.

East St. Louis, Ill.—Messrs. Niemes & Reimen were awarded the contract for the building of the East St. Louis Electric Light & Power Co., and will commence work immediately.

Council Bluffs, Ia.—The Council Bluffs Gas & Electric Light Co. has secured the contract for city lighting, and has closed a contract with the Sperry Electric Co., Chicago, for 95 arc lamps.

Schome, Wash.—The Fairhaven Electric Light, Power & Motor Co. has been organized by PIERCE EVANS, J. F. WARDEN, and GEO. A. BLACK. Capital stock, $100,000.

Ukiah, Cal.—GEORGE L. HENZEL and P. MAHONI, of San Francisco, and A. V. LAMOTTE, of Glen Ellen, propose to establish an electric light plant.

SEWERAGE AND MUNICIPAL.

Drainage.—*Pana, Ill.*—The Drainage Commissioners have let the contract for deepening that portion of the Lake Fork Ditch which lies in this township northeast of town.

Sewers.—*Brunswick, Me.*—Plans for a system of sewerage are to be made by F. DANFORTH, C. E., of Gardiner.

Brooklyn, N. Y.—The U. S. Sewage & Drainage Co. ha been organized by GEO. W. GEFFKEN, F. K. CASTNER an E. W. THOMPSON, to purchase from CHAS. SCHUHMEISTER the patents on improved sewer appliances.

Oakland, Cal.—The Sewer Committee will call for competitive plans for a system of sewers.

Vancouver, B. C.—Proposals are invited for the construction of 5 miles of sewer extensions. For particulars in regard to this work and the proposed garbage crematory address Mr. MOHUN, Sanitary Engineer.

Newark, N. J.—Sewer contracts have been awarded to P. H. Harrison and James Edwards.

Framingham, Mass.—The new sewerage works have been completed. They were built by Sherman & McDonough, of West Troy, N. Y. The sewage is pumped to the disposal works by two Davidson engines of 2,000,000 gals. daily capacity.

Street Work.—*Duluth, Minn.*—Cedar block pavement is to be laid on Bench St,

Salt Lake City, Utah.—The trial of vitrified fire brick paving on 1st and 2nd South Sts., is recommended. There are about 2,640 sq. yds., which would require 155,000 bricks 8½ by 4 by 2½ ins. They can be made and delivered for $10 per 1,000. They would be laid on a course of gravel 3 or 4 ins. thick, and grouted with sand and pitch. It is also proposed to lay some asphalt pavement on the same streets, so that the results of the two systems may be readily compared.

Water Gas.—A water-gas company has been organized at Peoria, Ill., by JOHN H. FRANCIS, I. W. JOHNSON, and S. A. KINSEY. Capital stock, $500,000.

Fuel Gas.—L. B. LEMARIE, of New Orleans, La., is interested in the company organized to build works for the manufacture of fuel gas. The company proposes building a plant to cost $2,000,000 if the franchise is granted.

WATER-WORKS.

NEW ENGLAND.

Warehouse Point, Conn.—Property owners have subscribed $1,800 to have hydrants put in for fire protection.

Newington, Conn.—The Board of Directors of the Water Company has elected the following officers: President and Treasurer, ERASTUS KILBOURNE; Secretary, J. S. KIRKHAM.

MIDDLE.

Newark, N. J.—Chief Engineer HERSCHEL of the East Jersey Water Co. is reported as stating that, while part of the company's work would be contracted for a large proportion of it will be done by the company. Several masonry dams will be constructed. Work will be commenced about April 1, 1890.

Sea Isle City, N. J.—The town has granted a franchise for a system of works.

Wilmington, Del.—Two stand-pipes, 23 ins. in diameter by 35 ft. high, respectively, are being erected.

Sandy Hill, N. Y.—The Directors of the Spring Brook Water Co. have elected the following new officers: President, LOREN ALLEN; Vice-President, S. H. KENYON; Treasurer and Superintendent, O. A. TEFFT.

Reynoldton, Pa.—The Town Council has passed an ordinance authorizing the issue of $12,000 of bonds.

SOUTHERN.

Wheeling, W. Va.—GEO. HORNUNG, of Cincinnati, O., has been engaged to report upon the defective work in the new reservoir.

Martins' Ferry, W. Va.—A vote is soon to be taken on the question of issuing $25,000 of bonds for extending the mains.

Fayetteville, N. C.—The Fayetteville Water & Improvement Co has been organized by W. S. COOK, W. W. RAY and others. Capital, $100,000.

Statesville, N. C.—A. J. EVANS, Chairman Committee on Water Works, has sent us the following:

When works are built the supply will probably be pumped from Spring Branch to a stand-pipe. Estimated cost $25,000. Nothing definite has been done. Work will probably be commenced in 1890.

Cordele, Ga.—The town will vote on the question of issuing $14,000 of bonds for building works on Dec. 14.

La Grange, Ga.—Bids are wanted for constructing works. Address W. S. ROBSON.

Tallapoosa, Ga.—Address the Tallapoosa Land, Mining & Mfg. Co. for information regarding the projected works.

Jacksonville, Fla.—City Engineer ELLIS has submitted an estimate of the cost of extending mains to East Jacksonville. Bids will probably soon be wanted for this and other work, and furnishing materials.

Anniston, Ala.—The contract for erecting the boiler and engine house for the new works being built by T. G. Bush, of Mobile, has been let by the Anniston Construction Co. to McDonald & Campbell, of Anniston. It will be 50 by 100 ft., and cost about $10,000.

Greenville, Miss.—Plans and specifications for a 4,000,000-gall. per day system, are being prepared by Scovil & Irwin, of Nashville, Tenn. There will be about 10 miles of mains.

Chattanooga, Tenn.—A contract has been let to the City Water Co. to erect a stand-pipe and supply Lookout Mountain with 3,000,000 galls. of water daily from the Tennessee river, 2,100 ft. below. Contract price $50,000.

Johnson City, Tenn.—Propositions are wanted for building works. Address I. T. JOBE, Mayor.

Murfreesboro, Tenn.—A 50 by 100 ft. stand-pipe is to be erected, and the mains extended. It is also reported that J. E. Thompson, of Manchester, will purchase the works, and that the above improvements will be made by him.

Covington, Ky.—At a recent meeting of the City Council it was agreed to accept the proposition of the Kentucky Central Railroad to furnish its shops with water free, if located in the city. The proposition states that the city shall lay and maintain a 10-in. main extending from Ninth St. along Madison Ave. to the tunnel.

Lebanon, Ky.—The new works have been approved by J. D. COOK, Consulting Engineer for the company, of Toledo, O. Scovil & Irwin, of Nashville, Tenn., were the contractors.

Mayfield, Ky.—Plans and specifications for a system of works will probably be prepared by Scovil & Irwin, of Nashville, Tenn.

NORTH CENTRAL.

Delaware, O.—The new works have been formally accepted by the City Council.

Marietta, O.—Bids for furnishing materials for the new works have been received by JOHN W. HILL, of Cincinnati, O., the Consulting Engineer.

Ypsilanti, Mich.—Engineer W. R. COATS, of Kalamazoo, informs us that the new works will be officially started about Dec. 1.

Peoria, Ill.—The city's plant has been turned over to Moffett, Hodgkins & Clarke, of Watertown, N. Y. The Peoria Water Co. has been organized by the above firm, and steps will be taken immediately to furnish the city with pure water, taking the supply from a new source.

Galesburg, Ill.—Plans for a new system of works are being prepared by CHESTER B. DAVIS, of Chicago.

Vandalia, Ill.—Works are projected. Address J. H. RINGE, City Clerk.

Washburn, Wis.—The new works have been formally accepted.

Rice Lake, Wis.—The Rice Lake Lumber Co. contemplates the construction of a system of water-works for its plant. The managers express a willingness to extend it to the business portion of the city in case they receive sufficient encouragement.

NORTHWESTERN.

Manchester, Ia.—City Clerk C. H. DAY has sent us the following information:

A vote in favor of constructing works was taken on Sept. 30. A committee has been appointed to investigate and determine what system will be best adapted to the city's needs and finances.

Algona, Ia.—The town has voted to expend $10 000 in constructing works. Bonds will be issued.

Keokuk, Ia.—The works are claimed to be inadequate to the wants of the city, and will probably be remodeled.

Hull, Ia.—Sealed proposals will be received at the office of the Mayor, until Nov. 15, for sinking an artesian well. Bidders will be required to furnish estimates per foot for each 100 ft. up to 1,500 ft., or a depth that will be necessary to furnish a good supply of water. Address ROBERT PATTERSON, Mayor.

Anamosa, Ia.—Extensions are to be made.

St. Paul, Minn.—The new 1,000,000-gall. pump for the Baldwin Lake pumping station is to be furnished by the Deane Steam Pump Co., of Holyoke, Mass.

Duluth, Minn.—Work is progressing rapidly on the company's new 3,500,000-gall. reservoir.

Elk Point, Neb.—The Milwaukee Co. is building an engine-house and sinking a system of driven wells, and will use steam in the future to pump with instead of the wind engine, which fails to supply the demand.

Casselton, No. Dak.—Rapid progress is being made in laying the mains to connect the three principal reservoirs which will furnish the new water supply for fire protection. Materials have also arrived for the construction of the reservoirs.

Newcastle, Wyo.—A water supply is to be secured from a lake six miles distance as soon as the town is incorporated.

Helena, Mont.—The Lump Gulch Water Co. has been incorporated with a capital stock of $800,000, divided into 6,000 shares. The objects of the company is to supply the inhabitants of the city of Helena with water for drinking and other domestic purposes, fire protection, sewerage, street sprinkling, and other needed purposes, and to engage generally in the business of supplying water for industrial purposes. The incorporators are: A. J. SELIGMAN, JOHN T. MURPHY, JOSEPH DAVIS, O. R. ALLEN, SHIRLEY C. ASHBY, and ANTON M. HOLTER.

SOUTHWESTERN.

Batesville, Ark.—It is reported that the company has commenced work.

Waco, Tex.—The Bell Water Co. has been organized. Its capital stock is $160,000.

Fort Worth, Tex.—Additions and improvements will be made.

Wichita Falls, Tex.—Correspondence is solicited with contractors. Address OTIS T. BACON Mayor.

Denver, Col.—RICHARD HOLME, Secretary and Manager of the Citizens Water Co., informs us that the contract for constructing a ditch 14 miles long, 5 ft. deep by 5¾ ft. wide at top, has been awarded to Joseph A. Osmer, at 17½ cts. per lin. ft. Also for constructing a 1,700 ft. 42-in. tunnel, cemented, to Frank H. Strong at $4 per lin. ft.

Salida, Col.—The city is to spend about $18,000 in improving its plant. G. F. Bateman & Son have been awarded the contract for pipe laying.

PACIFIC.

Port Townsend, Wash.—The proposition of the Port Townsend Water Co. to supply the city with water has been accepted by the City Council, and an ordinance passed authorizing the city to enter into contract with the company for 25 years, according to the terms of the proposition. A later report states that the Mount Olympus Water Co., which also submitted a proposition to the city, has purchased the Port Townsend Water Co's plant, franchise and rights for $40,000, and will carry out that company's plan for supplying the city with water.

Anacortes, Wash.—The Anacortes Water Co. has been incorporated with a capital of $25,000. Its object is to build and operate works for domestic and manufacturing purposes. Address M. A. SAWTELLE, of Port Townsend, Wash.

Mount Vernon, Wash.—We have received the following information from GEO. D. SINCLAIR:

A small system of works is to be constructed by the Mount Vernon Spring Water Co. Water will be pumped from springs to a reservoir. Contracts will be let, and work commenced, about Dec. 1. President, R. W. WILLIAMS; Treasurer, ED. ENGLISH; Secretary, R. W. WILLIAMS. Engineer, ORIN KINCAIRD. Population, 1,500.

Moscow, Idaho.—J. M. LIEUALLEN, City Clerk, informs us that the town has sold $25,000 of 7 per cent. bonds to W. N. W. Harris & Co., of New York.

Colville, Wash.—The Mountain Brook Water Co. has been incorporated at Olympia. Capital stock, $25,000. The trustees are: J. M. BUCKLEY, JOHN R. SLATER, and JOHN H. YOUNG.

Cascades, Wash.—The Cascade Water Power Electric & Improvement Co. has been incorporated at Seattle. Capital stock, $1,000,000. The trustees are: JOHN ARTHUR, HENRY M. CROCKER, WILLIAM COLLIER, and J LUTTSELL MURPHY. Its object is to build and own reservoirs, dig ditches, lay pipes, and operate electrical and water-works.

Seattle, Wash.—Surveys are being made by Consulting Engineer WILLIAMS, and City Engineer SCURRY, for a new source of supply. A considerable amount of supplies will probably be purchased, and a number of contracts letsoon.

Yreka, Cal.—The City Trustees have submitted specifications to the two water companies for the purpose of ascertaining prices at which they will furnish water for fire protection. The conditions are to construct a 200,000-gall. reservoir at such an elevation as to afford 200-ft. pressure on Main St. Hydrants to be erected at various points, and mains laid.

CANADA.

St. Thomas, Ont.—The capacity of Kettle Creek has been found by measurements to be adequate for the city's requirements, and it is now proposed to utilize it as a source of supply. A large dam will probably be constructed.

Chatham, Ont.—Address the Chatham WaterW-orks Co. for information regarding the projected works.

Vancouver, B. C.—The city is considering the question of purchasing the company's plant.

FOREIGN.

Australia.—The plan of the Brisbane water supply scheme has been adopted by the Queensland Legislative Assembly. It is estimated to cost about $2,500,000, and is calculated to supply 300,000 people.

ARTESIAN WELLS.

Hull, Ia.—Bids are wanted for sinking a 5-in. well. Address ROBERT PATTERSON, Mayor.

Mellette, Dak.—A well is being sunk by the town.

Albany, Ga.—Bids are wanted for sinking a 600 or 800 ft. well. Address NELSON TIFT.

Uniontown, Ala.—Chamberlain & Lang are sinking a well for the town.

Santa Fé, N. M.—The citizens have subscribed $3,000 and formed a local company to sink a test well. A contract has been made with J. S. Lefever, of Denver, to sink it 1,000 ft.

Piedmont, W. Va.—The electric lighting company is sinking a well. It is probable that another well will be sunk, as the company is to increase the capacity of its plant.

Australia.—The South Australian Government has accepted tenders for 10,000 ft. of artesian boring in different parts of the colony.

Yankton, Dak.—A well recently sunk is reported to be flowing 4,000 galls. per minute.

Parker, S. Dak.—Bids will be received until Nov. 20 for sinking and casing a 6-in. well. F. L. CLISBY is City Clerk.

IRRIGATION.

North Yakima, Wash.—The Fowler Ditch Co. has been incorporated at Olympia. Capital stock, $8,000. The trustees are: C. P. FOWLER, H. B. SCUDDER, and FRANK FOWLER.

Denver, Col.—The following companies have been incorporated to develop irrigating works in Arapahoe and Douglas counties: The Denver Water Storage Co., which proposes to build a large masonry dam across Cherry Creek Cañon, about 25 miles from Denver, at an estimated cost of $100,000. Using this reservoir as a base of supply, the Denver Colorado Irrigation Co., will build a canal to irrigate the land owned by the Denver-Arapahoe Land Company and neigboring and adjacent tracts. This large ditch with its designed and proposed laterals will be about 40 miles long, and of sufficient capacity to water about 40,000 acres of land.

California.—Several dams are being built in Lassen County to store water for irrigating purposes.